Mariners Weather Log

Fall 1991

Big Bay Lighthouse

Lake Superior
Big Bay, Michigan

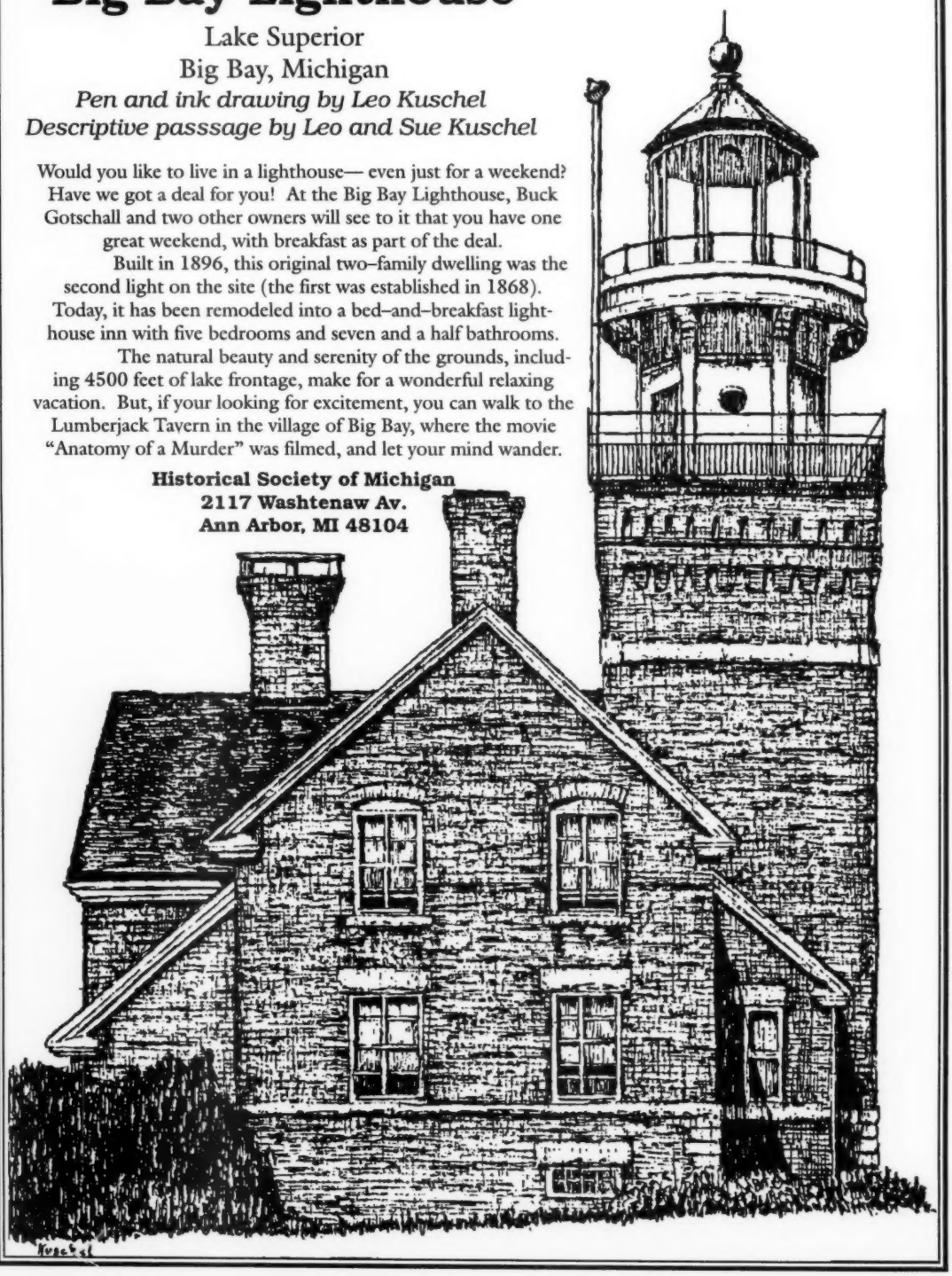
Pen and ink drawing by Leo Kuschel
Descriptive passsage by Leo and Sue Kuschel

Would you like to live in a lighthouse— even just for a weekend? Have we got a deal for you! At the Big Bay Lighthouse, Buck Gotschall and two other owners will see to it that you have one great weekend, with breakfast as part of the deal.

Built in 1896, this original two–family dwelling was the second light on the site (the first was established in 1868). Today, it has been remodeled into a bed–and–breakfast lighthouse inn with five bedrooms and seven and a half bathrooms.

The natural beauty and serenity of the grounds, including 4500 feet of lake frontage, make for a wonderful relaxing vacation. But, if your looking for excitement, you can walk to the Lumberjack Tavern in the village of Big Bay, where the movie "Anatomy of a Murder" was filmed, and let your mind wander.

Historical Society of Michigan
2117 Washtenaw Av.
Ann Arbor, MI 48104



Mariners Weather Log

October, November and December 1991
Vol. 35, No. 4

Great Lakes Special Issue

4
Lake Superior's Wicked November Storms*
Thom Holden
The **Edmund Fitzgerald** was a November victim.

12
The Silent Killer— Hypothermia*
Martha Walter
On the Great Lakes and wherever air temperatures drop below 50°F, there is potential danger for the Mariner.

18
North Coast Navigation*
U.S. Army Corps of Engineers
A brief history of the Great Lakes–St. Lawrence Seaway System.

24
Guardians of the Eighth Sea*
Denis L. Noble
The U.S. Coast Guard has an interesting history on the Great Lakes.

* related to the Great Lakes

The Joint Typhoon Warning Center summarizes the 1990 Typhoon Season. See page 54.

The U.S. Coast Guard evolved from four other services. Story on page 24.

Cover: The **Edmund Fitzgerald** sank on November 10, 1975 in heavy seas on Lake Superior. Its crew of 29 were lost. This photograph was a gift by the Oglebay Norton Co. to the Canal Park Museum of Duluth, MN.

Back Cover: The wreck of the **Edmund Fitzgerald** as viewed from the investigating ROV. This still photo was made from a video freeze frame by Harley Seeley of Michigan St. University.

Tibbetts Point Light, where you can spend a night or two. Elinor DeWire tells us how— Page 30.

Departments

30 Whale Oil and Wicks*
32 Sea Photography
35 Ocean Queries*
37 PMO Report
44 Editor's Desk*
46 Marine Observation Program
50 Tips for the Radio Officer
53 Mailbag
54 Hurricane Alley

Marine Weather Review

April, May and June 1991

62 North Atlantic Ocean
65 North Pacific Ocean
69 Pressure and Track Charts
78 Tables

Mariners Weather Log

Editor
Richard M. DeAngelis

Columnists
Elinor DeWire
Marty Baron
Michael Halminski

Computer Specialist
Gary Keull

Word Processing
Shirley Patterson

U.S. Department of Commerce
Robert A. Mosbacher, Secretary

National Oceanic and Atmospheric Administration
Dr. John A. Knauss, Administrator

National Environmental Satellite, Data, and Information Service
Thomas N. Pyke Jr., Assistant Administrator

National Weather Service
Elbert W. Friday Jr., Assistant Administrator

National Oceanographic Data Center
Ronald L. Fauquet, Deputy Director

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through July 1, 1992.

The *Mariners Weather Log* (ISSN:0025–3367) is published quarterly by the **National Oceanographic Data Center**, National Environmental Satellite, Data, and Information Service, NOAA, Washington DC 20235 (telephone; 202–606–4561). Funding is provided by the National Weather Service, NOAA. Data is provided by the **National Climatic Data Center**, NOAA. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington DC 20402.

National Oceanographic Data Center

Articles, photographs and letters should be sent to:

Editor, Mariners Weather Log
National Oceanographic Data Center
1825 Conn. Av., NW
Washington DC 20235.

Great Lakes

Any Port in a Storm

Jerry Bielski

U.S. Army Corps of Engineers Port Series Reports

Over 70 reports describing principal U.S. coastal, Great Lakes and inland ports are available. Each volume describes waterfront facilities for one or more ports. They include details on weather, currents, berthing accommodations, warehouses, cranes, marine repair plants, petroleum terminals and other vital port information. The Great Lakes are covered in the 40 series and several volumes include all the major ports on a particular Great Lake. These books contain foldout aerial photographic maps showing the locations of the facilities and each volume is periodically revised to keep information up–to–date. The books are individually (reasonably) priced and advance payment is required. For a complete list of Port Series Reports write:

Water Resources Support Center (CEWRC–NDC–P)
Casey Building
Fort Belvoir, VA 22060–5586

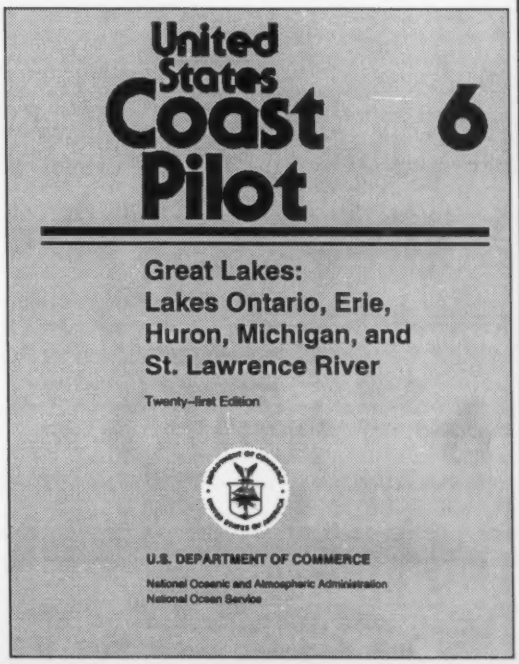
NOS Knows the Great Lakes

The National Ocean Service Coast Pilot

This series of nine nautical books covers a wide variety of information important to navigators of U.S. coastal and intracoastal waters, and the waters of the Great Lakes. This is information that cannot easily be shown on standard nautical charts and includes but is not limited to:

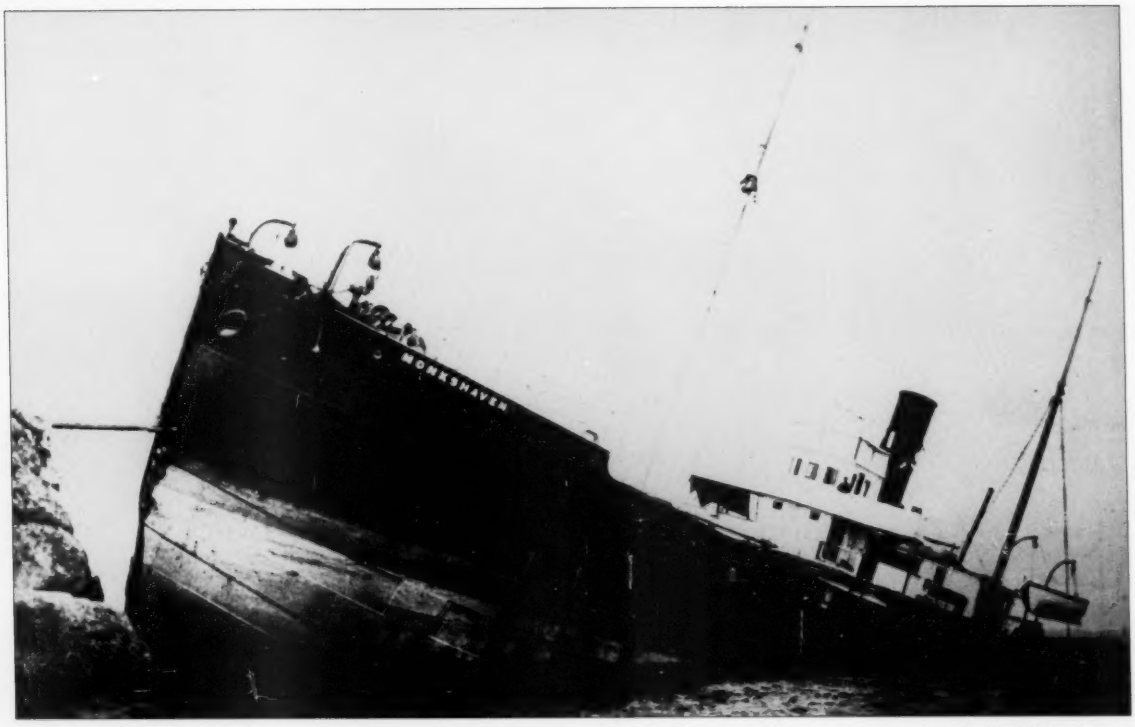
- channel descriptions
- anchorages and pilotage
- bridge and cable clearances
- currents and ice conditions
- tide and water levels
- weather and climate
- dangers and prominent features
- routes and traffic separation schemes

FOR SALE BY NOS AND ITS AGENTS
Distribution Branch (N/CG33)
National Ocean Service
Riverdale, MD 20737-1199



Lake Superior's Wicked November Storms

Thom Holden



Canal Park Marine Museum

This is a slightly edited version of an article, which originally appeared in color in the November 1990 issue of the beautiful ***Lake Superior Magazine*** *. We thank them for letting us use it. Thom Holden is the Assistant Director at the Corps of Engineers' Canal Park Marine Museum in Duluth, Minnesota. He is also author of* ***Above and Below: A History of Lighthouses and Shipwrecks of Isle Royale*** *and a contributing editor to* ***Lake Superior Shipwrecks.***

November. No other month of the year offers more challenges for Lake Superior navigators than the month of November, when the quiet breezes of autumn can turn into monstrous storms – killer storms – that can cause concern even on the largest and newest of vessels caught up in the lake's fury. November can be wicked, and often is.

The single most devastating November storm to hit Lake Superior was the **Mataafa Storm** of 1905, in which more than two dozen ships suffered everything from light damage to fatal sinkings, including the ***Mataafa,*** for which the storm was named. That ship alone lost nine of its crew while marooned in the icy waters just yards offshore at Duluth, Minnesota. And perhaps the next most famous storm catastrophe in Lake Superior history occurred on November 10, 1975, when the large ore carrier ***Edmund Fitzgerald*** with its crew of 29 was lost in the stormy

The British "tramp steamer" Monkshaven grounded on Pie Island, Thunder Bay, along the Canadian north shore on November 28, 1905 (left). She was salvaged a year later only to founder and become a total loss during the salvage voyage. To the right, is a typical November scene aboard an ore carrier on Lake Superior. Below is the ***Socrates****, which was driven aground in a November storm.*

Jerry Bielski

waters of eastern Lake Superior off Whitefish Point.

Recollections of November shipwrecks linger with all who sail, particularly as late season weather brings daily reminders of the awesome power which can be unleashed by Lake Superior.

... in the midst of a hurricane-force storm, the Edmund Fitzgerald and her crew sailed into history. ...

There are many embraced by the enticing allure of Lake Superior and its history, captivated by the mystery and mystique, and the unresolved questions surrounding the loss of the ***Edmund Fitzgerald***, with all hands. What caused the accident? And could it happen again?

Captain Ernest M. McSorley, 27 crewmen and 22-year-old Deck Cadet David E. Weiss set sail from the ore dock on Allouez Bay in Superior, Wisconsin, on an unusually pleasant November day. More than 26,000 tons of taconite lay in her hold bound for the lower lakes. Just a day later, in the midst of a hurricane-force storm, the ***Edmund Fitzgerald*** and her crew sailed into history, becoming part of the enigmatic heritage of the greatest of the Great Lakes.

It was the first total-loss shipwreck on Lake Superior in 23 years. Two formal casualty investigations, one by the U.S. Coast Guard and the other by the National Transportation Safety Board, were unable to positively recount the entire event. Even the wreck itself, surveyed as part of the investigation, was unable to absolutely disclose what had happened. Both casualty reports recommended numerous improvements and changes in procedures.

There have been two additional observations of the ***Fitzgerald*** since these reports. The first was by a Jacques Cousteau team which observed the wreckage from a two-person submarine carried aboard the ***Calypso*** in 1980. They concluded that the ***Fitzgerald*** may have broken on the surface, the bow and stern sections colliding with one another as the vessel plunged to the bottom. Not all share that conclusion.

Another group from the Office of Sea Grant at Michigan

Jerry Bielski

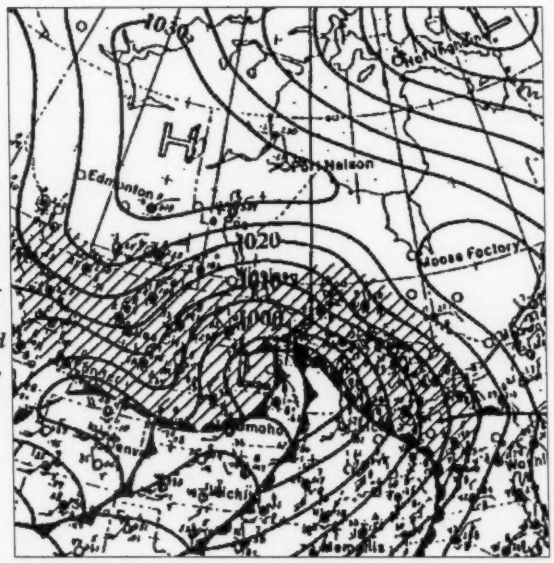
State and the University of Michigan observed the wreckage in 1989 using 3-D video electronics. This investigation was undertaken as much to obtain fresh video imagery as to test the potential of the equipment.

Weather forecasting techniques are measurably improved. Navigation instrumentation is more reliable and precise.

Although the video was reviewed by a panel of experts and certain details were made clear, no conclusions were reported in the limited statements publicly disclosed by participants. Additional work is on-going at Sea Grant involving computer analysis, enhancement and manipulation of the video data.

Despite the formal investigations, independent surveys and many theories evoked by the unexplained loss, the single most intriguing question of what caused the loss remains unanswered.

Could a similar accident occur today? The answer, though qualified, must inexorably be yes. The weather can become just as violent today as it was in 1975. There are dozens of similar sized vessels still operating, many older than the ***Fitzgerald*** when she was lost, and several much larger. But age and size don't always matter to Lake Superior. And while there have been substantial improvements in the Coast Guard's vessels available for search and rescue, it is not likely they would be able to operate substantially more effectively in the sea conditions which surrounded this casualty.



However, there is a heightened consciousness of safety by fleet owners, operators and sailors alike. The exposure survival suits now required may well guarantee survivors, or at the very least the recovery of some of those lost. The Emergency Position Indicating Radio Beacon (EPIRB) provides for an almost instantaneous positive location of an accident, allowing available search and rescue efforts to quickly narrow the area covered. Weather forecasting techniques are measurably improved. Navigation

Northeast Minnesota Historical Center

*The **Mataafa** (left) lay frozen in the ice off Minnesota Point on Christmas morning 1905. The storm had claimed nine lives. The ship was salvaged in the spring. Above is the Weather Bureau's view of the Mataafa Storm at 1300 UTC on the 28th of November 1905. On the next page are the steamer **Lafayette** and the barge **Manila** on the rocks about 6 miles northeast of Two Harbors. One crewman died aboard the **Lafayette**, which broke in two. Its quadruple expansion steam engine was later reused in the **J.S. Ashley**, built in 1909. The **Manila** was salvaged.*

Canal Park Marine Museum

instrumentation is more reliable and precise. There has been additional experience with casualties under a variety of circumstances. And, the Coast Guard has experienced a shipwreck of its own with the stranding and subsequent loss of the buoy tender ***Mesquite*** off the tip of the Keweenaw Peninsula at the close of 1989.

"Then the weather gods threw their most wicked curve."

A casualty such as the ***Fitzgerald's*** could occur again. All must be prepared for such an event while hoping this history does not repeat itself.

No other storm in the history of Lake Superior, then or now, ravaged as many ships in a single sweep or touched so many lives as did the storm of November 27–29, 1905. All subsequent storms in the next half century and more were compared to that one, and most fell far short in their ferocity. Not until the loss of the ***Henry Steinbrenner*** in 1953 and the ***Edmund Fitzgerald*** in 1975 would a storm and shipwreck receive such wide and continuing media coverage.

Dr. Julius F. Wolff Jr. best describes the storm in his *Lake Superior Shipwrecks*:

"When storm warnings were raised for the western lake on November 23, most captains stayed in port, a wise decision. A tumultuous northeaster with torrents of rain splashed the western lake country on the 23rd, changing to heavy, slushy snow. Winds of 60 miles an hour blasted Duluth on the 24th. Decent weather returned on the weekend of the 25th and 26th, continuing through part of the 27th. Accordingly, ships by the dozens steamed out on the lake in the end-of-season rush, particularly since big storms usually have been followed by periods of relative calm. Then the weather gods threw their most wicked curve. In a phenomenon probably never before nor afterward recorded in American weather annals, rather accurately maintained since the 1870s, a far more violent gale and snowstorm blasted the Lake Superior Country just 3 days after an admittedly wild tumult. The weather forecast on the morning of the 27th was a disconcerting call for fair and cold. Storm signals were hoisted since heavy snow was falling over northern North Dakota, behind which was an enormous cold wave. Of course, this might possibly miss Duluth. It didn't.

"Snow began to fall at Duluth about 6 p.m., November 27. Within an hour, the winds were reaching 44 miles an hour. As the night wore on, winds grew stronger and stronger until

70 miles on hour was officially registered at 5:40 am. The tempest raged at higher than 60 miles an hour for more than 12 hours. One official report said 79 miles an hour was reached. Clouds of snow cascaded down. The whole western lake was enveloped, including the Canadian lakehead. St. Paul was being plastered, and the snow was heading toward Chicago. Indeed, on the morning of the 28th, Duluth weather forecaster H.W. Richardson no longer could get data on the magnitude of the storm mass. Telegraph and telephone communications with the Weather Bureau headquarters in Chicago were out. Train and street car traffic was paralyzed in the Upper Midwest. Downed telephone and telegraph poles blocked streets and roads, while areas of Duluth near lake level were flooded.

"As bad as things were on land, this experience was sheer hell for sailors. Snow cut all visibility. Waves seemed to run higher than pilothouses or smokestacks. Even new 1,800-horsepower, 478-foot steel ships were stopped cold when fully loaded. Some days elapsed before the full story was known. When the toll was tallied, 18 ships were discovered to be disabled or destroyed by stranding, one had foundered with all hands and nearly a dozen others suffered various degrees of injuries to hulls or superstructures. All except two had come to grief west of Keweenaw Point. Five of the mishaps had fatalities. In lake history, this is called the 'Mataafa Blow', in memory of a major steel carrier wrecked at the Duluth pierhead."

The names of the many vessels involved in the Great Storm of November 1905 are often recalled, but most of those individuals who observed and participated in and died in the ordeal have been left on the periphery of history. Fortunately, some of the photographs and illustrations of the events as well as various media records have survived to shed light on that unparalleled time and some of the circumstances which found individuals caught up in the making of history.

Watchman Arthur Daggett of Collingwood, Ontario, was an inveterate shipwreck survivor. Some sailors seem ingrained with an extra sense of survival. He had his first brush with disaster when a schooner sank from beneath him following a collision on Lake Michigan. Then, in 1902 just off the Duluth Entry, the ***Thomas Wilson*** was struck and sunk by the ***George G. Hadley***.

STEAMER "MATAAFA" WRECKED OFF PIER OF DULUTH SHIP CANAL, DURING THE GREAT STORM OF NOV. 28, 1905. NINE MEN WERE LOST FROM THIS VESSEL.

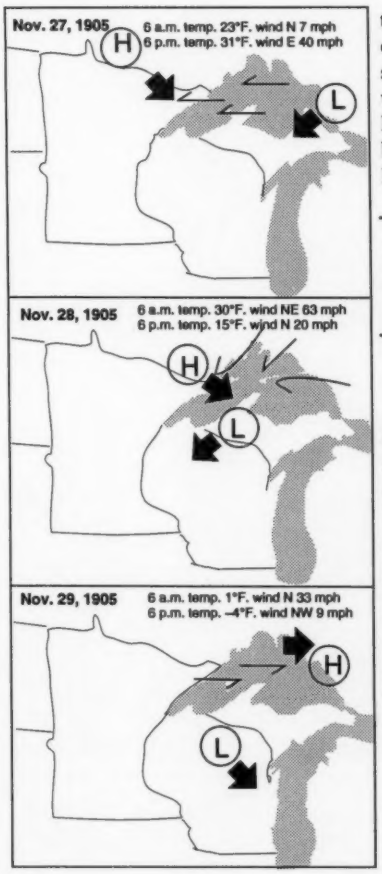
Daggett, who was asleep in his cabin at the time, managed to swim to the ***Hadley***. In 1905, luck was with the 28-year-old sailor again as a survivor of the ***Crescent City*** wrecked on Lake Superior's north shore just at the eastern edge of Duluth.

Well up the north shore another sailor with an instinct for survival saved most of his shipmates. As the steamer ***William Edenborn*** made her way southward with consort ***Madeira***, the towline parted. The hapless barge was on her own as the steamer disappeared. Two hour later, the ***Edenborn*** was on the rocks and breaking apart, although 24 of her 25-man crew survived to be rescued by the tug ***Edna G.*** of Two Harbors.

Perhaps the most widely criticized by onlookers during the storm were the U.S. Life Saving crew stationed out on Minnesota Point in Duluth.

Meanwhile, the powerless ***Madeira*** also drifted toward the rocky coast. She crashed against the bold bluffs just north of Split Rock and immediately began breaking apart as she pounded in the surf. Seaman Fred Benson saw time running out. He watched a moment and then made a dramatic leap for the rocks just as his vessel crested a wave. He made it. Working his way to higher ground, he dropped a weighted line to his shipmates below. One by one they scrambled up the line. Only Mate James Morrow drowned when he was earlier washed overboard. The ***Madeira*** became a total loss, but eight crewmen had survived because of the daring deed of a young seaman.

The security of land did not always provide the best shelter. Captain John H. Malone keeper of the Isle Royale Light on Menagerie Island, Michigan, just a few miles from where the steamer ***Bransford*** stranded in the storm, said after returning to port on the ***Bon Ami*** that the seas in that storm were enormous, crashing directly over his little island for more than 2 full days. Freezing lake waters flooded his quarters despite being protected by massive iron shutters over


Nov. 27, 1905
6 a.m. temp. 23°F. wind N 7 mph
6 p.m. temp. 31°F. wind E 40 mph
H
L
Nov. 28, 1905
6 a.m. temp. 30°F. wind NE 63 mph
6 p.m. temp. 15°F. wind N 20 mph
H
L
Nov. 29, 1905
6 a.m. temp. 1°F. wind N 33 mph
6 p.m. temp. –4°F. wind NW 9 mph
H
L

The storm over Lake Superior in late November 1905 developed rapidly when a high pressure system from Canada clashed with a stalled low pressure cell over the lake. As the temperatures dropped, snow and hurricane-force winds engulfed the western two-thirds of the lake. The nor'easter was responsible for many deaths and much property damage. Richard J. Westergard, National Weather Service Office in Duluth helped recreate this weather pattern.

On the preceding page is an example of some of the many photographs from the Mataafa Blow of 1905, which ended up as illustrations. The most resourceful capitalization on the wrecks of the storm was the colorful rendition of the Mataafa casualty portrayed by Leonard Van Proagh of the Duluth Cigar Company, who chose the vessel and two wreck views to illustrate the inside of the lid for their boxes of Mataafa-brand cigars.

the windows. The boathouse had completely washed away. He had seen nothing of the ***Bransford*** which straddled a reef and badly holed herself before being uplifted by a giant wave and released to limp safely into port.

Although the Mataafa was close to shore she was isolated.

Perhaps the most widely criticized by onlookers during the storm was the U.S. Life-Saving crew stationed out on Minnesota Point in Duluth. It was felt by some that they had failed by not promptly rescuing the entire crew of the ***Mataafa***, which lay little more than a stone's throw off the beach. However,thorough investigation into the lifesaving crew's actions resulted in complete exoneration. They had done their best under trying circumstances.

At the time the ***Mataafa*** and her 24-man crew crashed into the Duluth Ship Canal, the lifesavers, under command of Captain M.A. McLennan, were already busy further out on Minnesota Point in the grueling, but successful breeches buoy rescue of the crew of the ***R.W. England*** aground in the breakers just offshore. Park Pointer Fred J. Cosford had witnessed the ***England*** incident and notified McLennan's crew.

"I never saw anything like that vessel when I first noticed her," Cosford said. "She was high in the air on the crest of an enormous wave, which seemed to descend more rapidly than she, for I could see daylight under her for seconds as it seemed."

The captain of the ***R.W. England*** commented a few days after the accident that Captain McLennan and his lifesaving crew were efficient, intelligent and rapid in their miraculous effort to reach his vessel through snow, fallen trees and downed telegraph poles at the height of the storm. He said, "I found all I could do to walk."

In the meantime, the 430-foot steamer ***Mataafa***, having attempted to navigate the lake with a barge in tow, was forced to return to safety of the Duluth Harbor. Dropping the tow to fend for itself, the ***Mataafa*** made for the Duluth Ship Canal. Suddenly a tremendous wave stopped the ship and slammed it into the north pier of the canal. Waves then turned her sideways to the canal. The battering persisted, rotating the vessel 270 degrees before sending her aground only a few hundred feet offshore. The constant pounding of the seas wracked her hull.

The situation at the Superior Entry Lighthouse was equally bad. The easterly seas running there were so violent that a portion of the fog signal building was swept away.

Although the ***Mataafa*** was close to shore, she was isolated. Crowds of Duluth residents took up positions on shore, unable to effect any rescue efforts. Captain McLennan said that his crew, which had already been up all night at the England wreck, was at the ***Mataafa*** scene within an hour and a half of being notified of the wreck. They had hauled their beach cart more than 2 miles through sand, snow drifts and water, and then had to wait to be ferried across the canal. They fired lines from shore to the wreck to no avail. They worked until nearly midnight when an official of the Pittsburgh Steamship Company said he heard Captain Humble shout from the ***Mataafa*** that all the men were forward and safe. It was only then that McLennan's crew rested. McLennan him-

Northeast Minnesota Historical Collection

self did not.

Still the crew was criticized for not launching their boat. McLennan replied that the boats were necessarily light and would have broken on the rocks or been crushed in the debris. Captain Green of the tug ***Superior*** and other tug masters would not venture out in the storm to tow a boat out to the wreck. It was not until first light the following day that McLennan and his men set out for the wreck to bring ashore 15 weary survivors. Nine had perished, all at the aft end of the boat.

A Pittsburgh Steamship Company official, himself a former lifesaver, said, "The boat has not yet been built which could have reached the men on the ***Mataafa*** on the day of the wreck. In the first place, I believe it utterly impossible to have launched the boat, let alone get it to the stricken vessel afterwards."

First Mate William McLean of the Angeline was one of many sailors who valiantly worked to save their ships.

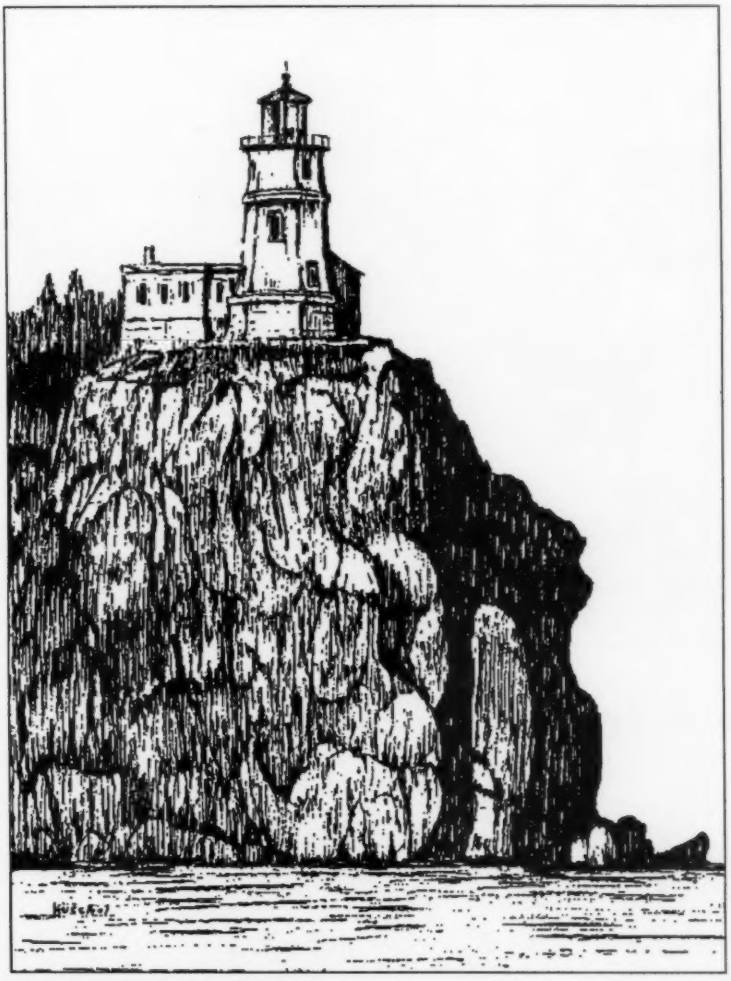
The lifesaving crew later had the gruesome task of removing the dead from the ***Mataafa***, their bodies frozen in agonizing positions of desperation. Four were recovered on board, one washed ashore and another recovered later. Among those who perished was cook Walter Bush of Amherstburg, New York, perhaps the only black sailor to become a victim of the storm. Hard-hat diver W.E. Hoy and dive tender William Hargreaves had the equally grim task of searching the interior of the wreck and the surroundings waters for

First Assistant Engineer C.A. Farringers, Second Assistant Engineer James Early and Oiler William Gilchrist.

There were other unsung heroes in the storm. One was Assistant Lighthouse Keeper Thomas White, whose station was at the Duluth Entry. When the storm first arose, White made his way to the light to tend it and the foghorn, only to become marooned there for the duration of the storm. The main keeper, Captain James Prior, had attempted passage to the lighthouse through the tunnel built inside the new piers for just such an occasion, but found it completely flooded and impassable in the high seas. Waves crashing over the piers and running virtually their full length prevented him from getting to the station. He was twice washed off the south pier in attempting to get to

the pierhead light. White was marooned for the duration of the storm without rest, but kept the light burning throughout. Captain Prior managed to keep the inner range light burning, but it took 2 hours to clear enough ice from the structure to pry open the lower door.

The situation at the Superior Entry Lighthouse was equally bad. The easterly seas running there were so violent that a portion of the fog signal building was swept away. Keeper Thomas Doody and his assistant, Harry Baker, worked in waist deep water to maintain the station until they finally had to abandon it to the elements. The lighthouse, too, succumbed.



On the preceding page, the U.S. Life Saving crew from Minnesota Point was finally able to make their way out to the Mataafa and bring back 15 weary survivors the morning after the storm. Along with Rock of Ages Light, built in 1908, Split Rock Light (above) was built in 1910, as a result of the Mataafa Blow. The Split Rock light is 168 feet above the water and 54 feet above the ground. It was featured on the inside cover of the Winter 1988 issue of the Mariners Weather Log. The sketch was done for the Historical Society of Michigan by Leo Kuschel.

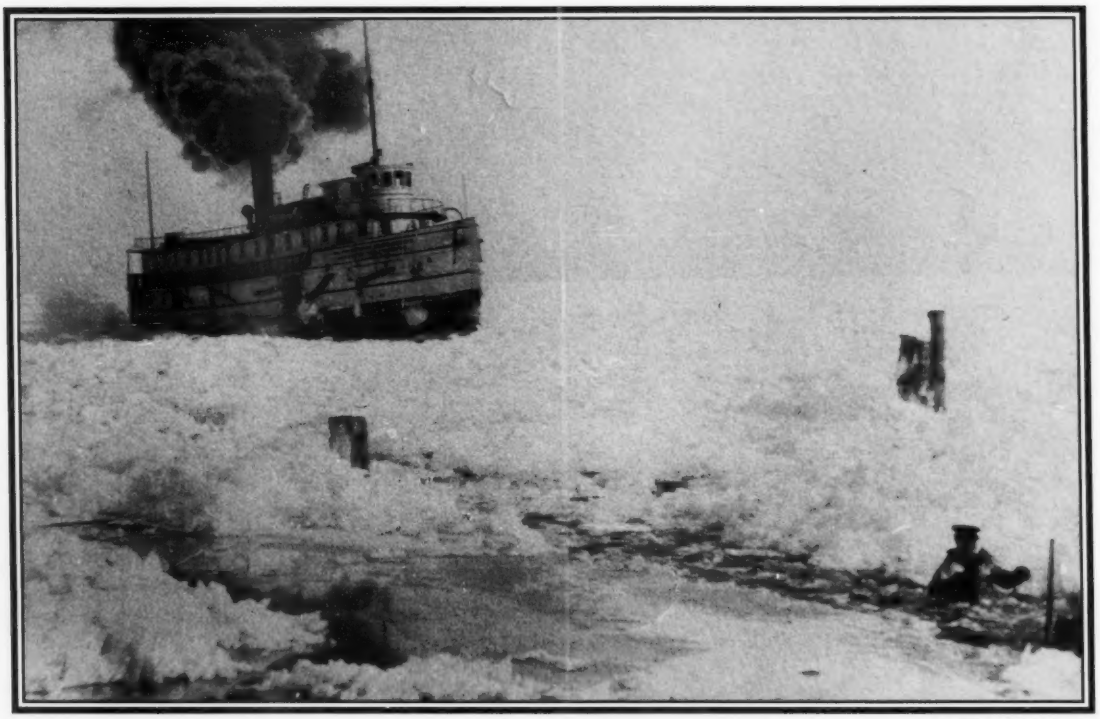
First Mate William McLean of the ***Angeline*** was one of many sailors who valiantly worked to save their ships. The ***Angeline*** was caught by the storm when off the Keweenaw Peninsula downbound from Duluth with ore for Detroit. When Captain S.A. Lyons feared his vessel would be driven onto the dreaded reefs off Eagle Harbor, he turned to the open lake. While wallowing in the trough of the sea and throughout the storm, McLean had the task of constantly checking the fastenings on the hatch covers. He made his perilous rounds with a line fastened around his waist and two of the crew standing by. He was once engulfed by waves, but dragged back along the deck. Enormous waves then washed him over the side where fellow crewmen rescued him again. The ordeal lasted 48 hours with seas cresting over the smokestack. Fortunately, the ***Angeline*** suffered only topside weather damage, and there were no casualties among the crew.

The heaviest fatalities occurred with the disappearance of the grain steamer ***Ira H. Owen*** near Outer Island in the Apostles. Observed by another ship to be in trouble on the morning of November 28, the disabled vessel was soon engulfed in the storm.

Proof of her demise came only with the recovery of debris, including a life ring, 2 days after the storm. The ***Owen*** was the only steel-hulled vessel to perish in the storm. The captain and a crew of 18 were lost.

Within 5 years of the **Mataafa Storm** two badly needed lighthouses were built to assist mariners along the Minnesota north shore: Rock of Ages in 1908 and Split Rock in 1910. Both structures remain, but only Rock of Ages is now operational, albeit with a tiny solar powered lamp.

Have your best friend read this article. It may save your life.



Canal Park Marine Museum

The Silent Killer— Hypothermia

Martha Walter

Your working on deck and its in the 40s (°F)— a little cold. Rubbing your hands together and shivering, you think "I should really go back in and get some gloves and heavier clothing. Ah, I'll only be out here for a little while. I'm a mariner not a wimp." The shivering finally stops, but your mind becomes a little groggy and you begin to move a little clumsily. You have to stop and think "what was I doing?" A buddy asks if you've had a few. "Nah, I'm okay" is your answer.

Well your not in the twilight zone, but almost. You may be well into severe, silent hypothermia. Fairly soon you will become semiconscious or even unconscious, blue-gray and stiff as a carp— not a pretty thought or sight. Let's hope your buddy knows the signs.

Hypothermia–overexposure–has been called "the killer of the unprepared." Fortunately, most mariners recognize cold exposure as an ever-present threat, and recognition is the first step towards preparation. How to prepare? Proper dress, safe practices, rescue drills, knowledge, and a positive attitude can protect you and your crew members from a hypothermia tragedy.

Hypothermia occurs when the body loses heat faster than it produces it. The body's inner core temperature (normally 98.6°F; 37.3°C) begins to fall, causing failure of vital organs. Symptoms become more

severe as body temperature declines, and below 78°F (26°C) death is likely. The rapid progression of mental and physical collapse that accompanies hypothermia requires that immediate first aid be employed.

Although commonly caused by immersion in cold water, hypothermia may also result from chilling winds, rain, and perspiration. Thus, mariners must be alert to the possibility of hypothermia while working on deck or in other exposed conditions, as well as in man-overboard situations.

Two Types

The form of hypothermia one experiences depends on the length of time over which the condition develops. Acute or sudden-onset hypothermia is usually the result of sudden immersion in cold water. Cold water can cool the body as much as 25 times faster than air, so chilling begins immediately and progresses rapidly. Some individuals may be endangered in water only slightly cooler than body temperature, so mariners in tropical climates should not dismiss this hazard.

Chronic or long-onset hypothermia may develop with exposures usually greater than 12 hours and can develop over the course of several days. Long-onset hypothermia usually occurs when individuals working in temperatures below 50°F (10°C) become wet through precipitation, sea spray, or perspiration. Freezing temperatures are not required to produce hypothermia. Victims of chronic hypothermia may experience "silent hypothermia," in which the gradual onset of cold produces physical and mental fatigue unaccompanied by shivering or other usual indications of cold.

Symptoms

Mildly hypothermic individuals will shiver and have painfully cold hands and feet that may become numb and lose dexterity. As the condition progresses, the individual will stop shivering, become confused, and exhibit poor coordination, speaking difficulties, disorientation, and poor judgment. These symptoms usually occur when the body core temperature slips below 90°F (32°C). At this stage, the victim may argue that he is fine, although he is actually suffering from severe hypothermia. As the condition worsens, the individual will become semiconscious or unconscious, and experience increasing muscular rigidity. Below 82°F (28°C) the victim may appear dead, with extreme rigidity, little or no apparent breathing or pulse, dilated eyes, and cold, bluish-gray skin. It is important to assume the patient can be revived, even at this stage, and to continue treatment.

Rewarm Gradually

Obviously, the cure for hypothermia is to rewarm the patient. There are right ways and wrong ways to do this. **The right way is to stop further heat loss and very gradually rewarm the core.**

The mildly hypothermic individual's own biological processes can be depended on to rewarm him, but in more advanced hypothermia heat must be applied. The patient must be placed on his back in a situation where further heat loss will not occur. If at all possible find a warm location, preferably a heated room below deck. Be sure the patient is insulated from a cold floor by blankets or other materials. Carefully remove all wet clothing. Wrap the patient's body in blankets, clothes, or a sleeping bag. If in an exposed situation, a plastic garbage bag will

Martha Walter is a Senior Editor for the NOAA Michigan Sea Grant College Program. NOAA's Sea Grant programs in all coastal states conduct research and educational programs on water safety, marine engineering, coastal processes and other marine and Great Lakes issues.

Jerry Bielski

Great Lakes mariners have always exposed themselves to hypothermia. Not usually, however, in the manner of the crewman (above left) in a circa 1895 photo taken in the Duluth Ship Canal The winter conditions (right) are the worst, but not the only time that cold and damp can overcome the strongest mariner.

U.S. Coast Guard

Crewmen of the Coast Guard Cutter ***Achushnet*** *watch First Class Hospital Corpsman Lewis Openshaw (above) apply CPR to an unconscious survivor from the dredge* ***Cartagena.*** *The survivor, Merle Robinson, became entangled in a line and was lying lifeless in his liferaft. After 7 minutes of CPR, signs of life began to return and 3 hours later, Openshaw was able to get Robinson's body temperature back to normal. When he was brought aboard his body temperature was so low it did not register on the ship's clinical thermometer. This rescue action took place in the North Atlantic, some 200 miles off Cape Cod on December 26, 1961. The dredge had been battered by heavy seas and high winds and was drifting helplessly after breaking her tow. The Coast Guardsmen rescued the entire 10-man crew.*

protect the victim from the wind and reduce evaporative heat loss. Wrap the arms and legs separately to insulate them from further cooling. **Do not rewarm the arms and legs.**

Rewarming the body core should be done by applying dry heat to the head, neck, chest, and groin. You can use heating pads, chemical heat packs, hot water bottles, even objects you have warmed in the galley oven. Whatever you use, test them first on your own skin to be sure they are not too hot. Mild heat—comfortable to the elbow or wrist—is required. In the absence of, or in addition to, warm objects, warm the patient with your own body heat. With bare torso get under the coverings with the patient and press next to him or her.

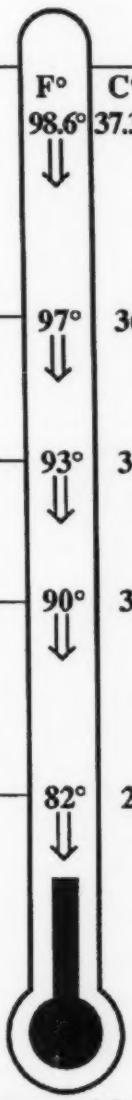
Only the body core—head, neck, trunk, and groin—should be rewarmed. **Warming the arms and legs can cause a serious, life-threatening reaction called afterdrop.** As the body cools it shuts off blood circulation to the extremities in order to conserve warm blood around the vital organs. If the extremities are included in the rewarming process, they will warm more quickly than the trunk. The brain will think the emergency is over and reopen the circulation. This will return cold blood to the vital organs, causing a renewed decrease in the core temperature, called afterdrop. This not only negates the warming that has already occurred, but may cause harmful or fatal additional stress to the body's vital functions.

Treatment for the mildly hypothermic individual (shivering, cold extremities) involves removing him from the exposed situation, providing warm, dry clothing, and allowing for plenty of rest. Such an individual should not be encouraged to exercise to "get warmed up again." Such activity only increases the circulation of warm blood to the extremities, further robbing the body core of heat.

The fully lucid, mildly hypothermic individual can be placed in a tub of warm water. The water should feel pleasantly warm to the wrist; it should not be hot. Be sure to place the individual so that only the trunk is in the water, with arms and legs out. The victim should not be placed in a shower where the extremities would also be rewarmed.

The victim should not be given any alcoholic beverages. Alcohol may relax the blood vessels in the arms and legs, allowing cool

HYPOTHERMIA FIRST AID



SYMPTOMS	F°	C°	*TREATMENT*
NORMAL	98.6°	37.3°	**ALL CASES** • Move victim to dry shelter and warmth • Handle gently • Remove wet clothes • Insulate body, head, and neck • Apply mild heat to body core • Rewarm gradually
MILD HYPOTHERMIA • Shivering; cold hands and feet • Still alert and able to help self • Numbness, clumsiness, pain from cold	97°	36°	**MILD HYPOTHERMIA** • Prevent further heat loss and let body rewarm • Give warm, sweet drinks; no alcohol or caffeine • Keep victim warm for several hours
MODERATE HYPOTHERMIA • Shivering may decrease or stop	93°	34°	**MODERATE HYPOTHERMIA** • Apply gentle heat to stabilize temperature • Offer drinks only after victim is fully conscious • Have victim checked by doctor if possible
SEVERE HYPOTHERMIA • Shivering decreases or stops • Loss of mental clarity; abnormal behavior • Victim appears drunk; may resist help • Semiconscious or unconscious • Muscular rigidity increasing	90°	32°	**SEVERE HYPOTHERMIA** • Avoid jarring victim; handle gently • Ignore pleas to be left alone • Lay victim on back; keep immobile • Apply mild heat
CRITICAL HYPOTHERMIA • Unconscious; may appear dead • Little or no aparent breathing or pulse • Skin cold; may be bluish-gray • Eyes may be dilated • Very rigid	82°	28°	**CRITICAL HYPOTHERMIA** • Assume patient is revivable; don't give up • Look, listen, and feel for breathing and pulse for 2 minutes. If there is any at all, do not give CPR. If none, begin CPR • Medical help imperative

Body temperature (taken rectally)

Adapted with permission from the United States Yacht Racing Union

blood to return to the core. In fact, no beverages should be given at all until the victim is fully conscious and able to swallow without choking. Then, non-alcoholic warm fluids, particularly water and fruit juices, will be helpful. Avoid caffeine drinks such as coffee, tea, and cocoa. Cigarettes also have a negative effect.

Handle Gently

In a man-overboard situation, where the victim may be suffering from severe hypothermia, it is extremely important to handle him gently. His system is in a very fragile state. Rough handling can cause further stress to the circulatory system, even causing a heart attack. Carry him horizontally if you have help, and handle gently through all stages of the treatment. Move the patient as little as possible. Check for pulse and respiration for at least 1 to 2 minutes.

Only if none is detected should you initiate CPR. **Rewarm very slowly.** Rapid rewarming can cause low blood pressure and fluid imbalances, and may be fatal. In cases of severe hypothermia, professional medical advice should be sought if at all possible.

Maintain a positive attitude and don't assume a cold patient is dead, even if vital signs are missing. He must be warm before you make the decision of whether to continue treatment. Also, watch your conversation! The patient may hear you, even though he appears unconscious. Don't say anything that would frighten or discourage him.

Be sure a hypothermia victim has completely recovered before he returns to duty. He may feel warm even before his temperature has risen. You must be sure his core temperature, not just his skin, has returned to normal before he begins usual activities. Examination by a physician is recommended if at all possible. Give the rewarmed patient warm liquids, keep him quiet, and watch him closely for any return of symptoms.

Remember that a crew member who has been quickly plucked from cold water may still suffer from mild hypothermia and may be at risk due to the shock to the circulatory system of hitting the cold water. He should be treated for hypothermia until his core temperature returns to normal.

Prevention the Best Cure

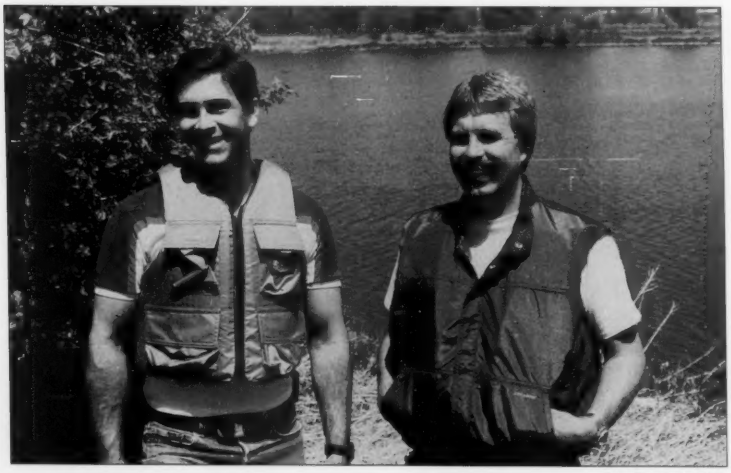
Be prepared for cold weather and water by dressing properly, wearing a flotation device, and practicing safe procedures. For on-deck dress, layering is the key to staying dry, warm, and comfortable. Wear a number of garments that can be donned or removed depending on the weather and your level of exercise. At least one layer should be wool or polypropylene. Unlike cotton or down, these retain their insulating ability even when wet. Always have a covering for your head in weather below 50°F (10°C). As much as 50%-70% of your body heat loss is through your head. Eat high-energy foods and drink water regularly.

PFDs

Personal flotation devices (PFDs) are essential aids to avoiding both drowning and hypothermia if you accidentally enter the water. Not only do properly fitted PFDs keep your head above water, but they provide thermal protection by keeping more of your body out of the water and enabling you to assume the Heat Escape Lessening Posture, or HELP position.

Dive Rescue Inc./Intl.

Type I PFDs, or lifejackets, are designed to turn you face up and they allow you to assume the HELP position. Type II PFDs, or horse-collar jackets, are effective in calm water, but may turn you face down in choppy seas. The performance of Type III PFDs varies considerably. These are the jacket- and vest-style PFDs most commonly worn. You cannot depend on all Type IIIs to turn you right-side-up or to enable you to maintain the HELP position. The effectiveness for you of a particular Type III PFD depends partially on your body type. It is imperative that you



Dive Rescue Inc./Intl.

Type III Personal Flotation Devices (PFDs) are the most comfortable to wear (left), but their performance varies considerably. Test yours in the water under controlled conditions.

Try to cover your mouth and nose with your hand if you fall into the water (above). This technique will combat the torso reflex, which is the body's automatic gasp for air when cold water hits the chest.

On the following page two people are floating in the Heat Escape Lessening Posture (HELP)- ankles crossed, knees drawn up and hands out of the water protecting the neck. Notice how the PFDs assist in floating and holding the head out of the water. A Type II PFD is being worn by the woman, while the man is wearing a Type I.

Dive Rescue Inc./Intl.

test your PFD in the water.

Wear your PFD. You want it with you if you fall overboard unexpectedly. Even if you are a strong swimmer, you can be quickly overcome by the cold water. The most effective PFDs are the most cumbersome, so a compromise must be made between flotation effectiveness and ability to perform your work on board. Whatever type of PFD you choose, be sure it fits you, and test it in the water in a non-emergency situation so you are familiar with how well it keeps you afloat. Signalling devices, visible in both daylight and darkness, should be stowed in your PFD.

In extremely cold, stormy, and dark conditions, you may wish to wear a work suit (pants or coveralls with jacket filled with flotation material) and to use safety line and harness.

In accidents where you must abandon ship, survival suits, or immersion suits, are the best protection. They will enable you to survive in cold water for an extended period of time. Survival suits should be stowed in an easily accessible location, and you should be able to don one in a minute. You may not have time to fumble. Be familiar with dressing procedures.

Emergency!

What if you find yourself in the water? It's important to remain calm and keep quiet. Thrashing about will hasten your body's heat loss and allow water to enter your clothing. If you do not have on a PFD, allow the air trapped between your layers of clothing to help keep you afloat by assuming a back float position.

Your chances of survival and avoiding hypothermia are greatly increased if you are wearing a PFD. A well-chosen PFD will enable you to adopt the HELP position. Keep knees together and pulled up as far as possible. Cross your ankles and hug your sides. This protects the high heat loss areas of the chest, armpits, and groin.

Climb on any floating object to get more of your body out of water. Even in wind, rain, and spray, you will be better off out of the water than in it. If there is more than one person in the water, huddle together to reduce heat loss with arms around each other with as much body contact as possible, especially at the chest. This technique is most feasible when the individuals are wearing PFDs.

Be Prepared

Reading this and other articles and books will not guarantee that you will know how to respond effectively in an emergency. It is essential that you practice how to respond if you are in the water, how to don a survival suit quickly, how to work with your crew mates in response to an emergency, and how to resuscitate a hypothermia victim. Frequent practice drills, supplemented by periodic demonstrations of new techniques and equipment, and conscientious exercise of safe shipboard practices and proper dressing, are key to avoiding cold exposure, or hypothermia, and its potentially tragic consequences.

Further Reading

Sabella, John. *The Cold Water Survival Handbook.* John Sabella & Associates, Inc., P.O. Box 17392, Seattle, WA 98107. 84 pp. 1989.

Pennington, Hank. *Fisheries Safety and Survival Series: Hypothermia.* Alaska Sea Grant College Program, University of Alaska Fairbanks, 138 Irving II, Fairbanks, AK 99775. 27 pp. 1991.

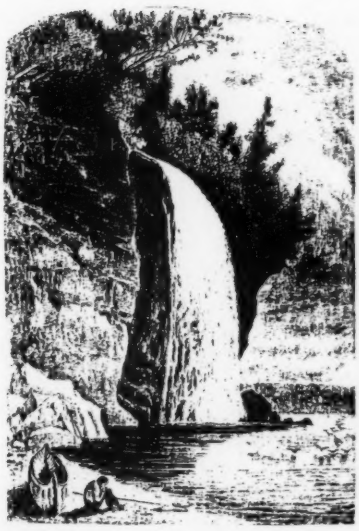
State of Alaska Hypothermia and Cold Water Near-Drowning Guidelines. Emergency Medical Services Section, Division of Public Health, Alaska Department of Health & Social Services, P.O. Box H-06C, Juneau, AK 99811. 16 pp. 1989.

Hypothermia First Aid. U.S. Yacht Racing Union, P.O. Box 209, Newport, RI 02840. Waterproof Card. 1982

The Great Lakes–St. Lawrence Seaway System has provided three decades of:

North Coast Navigation

St. Lawrence Seaway Development Corp.



Imagine a 1,000-foot freighter being lifted 60 stories by an elevator. This is what is accomplished by the Great Lakes-St. Lawrence Seaway sytem through a series of gigantic locks and the Welland Canal.

A little more than 30 years ago a civil engineering feat that rivaled the building of the pyramids was completed in North America, with the opening of the Great Lakes–St. Lawrence Seaway System. The Lakes and their connecting channels and canals form a 2,342-mile water highway, from the mouth of the St. Lawrence River to the heart of the North American continent.

When the St. Lawrence Seaway opened the Great Lakes to the Atlantic in 1959, it created, in essence, a North Coast for the U.S. and a South Coast for Canada.

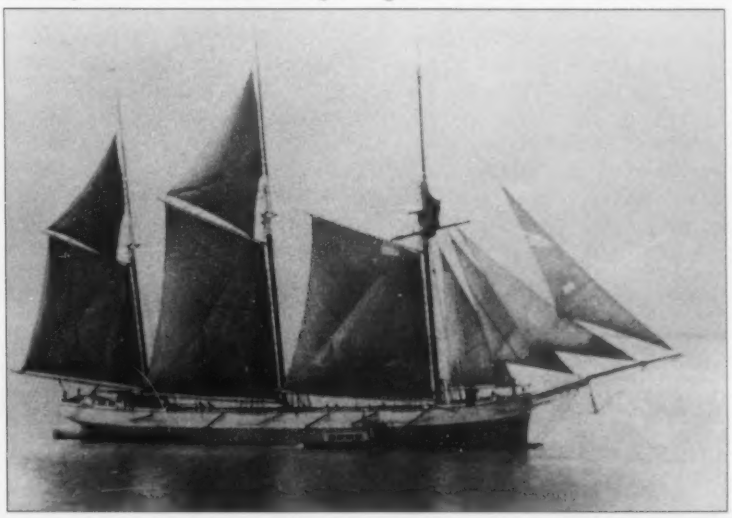
The major obstacles that had to be overcome included a 19-foot drop at the St. Marys River, at the outlet of Lake Superior, a 326-foot drop over Niagara Falls, and a 245-foot drop between Lake Ontario and the Atlantic Ocean. Once this was accomplished, ships could carry grain from Duluth-Superior and the Canadian Lakehead directly overseas.

Because of Great Circle navigation, ports like Cleveland, Toledo, Buffalo and Detroit are actually closer to Northern Europe than ports along the Atlantic Seaboard. For example, the distance from Detroit to Liverpool is 236 miles shorter than the distance from Baltimore to Liverpool. Add to this the 604 miles traveled overland from Detroit to Baltimore prior to the Seaway and the savings become substantial.

Long before the arrival of European settlers in North America, the early navigator Jacques Cartier, searching for a direct route to China, encountered obstacles at Lachine Rapids at Montreal, Quebec in 1534. The first commercial navigation on the Great Lakes is credited to Sieur de LaSalle's 10-ton sailing vessel launched in 1678 at the present site of Kingston, Ontario. This was followed by LaSalle's 40-ton ship, which was used for commerce on Lakes Erie, Michigan and Huron.

Westward migration followed the water course. The opening of territories that are now the midwestern states, along with the settlements that sprung up along the Great Lakes and St. Lawrence River, encouraged the use of commercial vessels for the hauling of grain and furs. Lake boats were

Information for this article was provided mainly by the U.S. Army Corps of Engineers, North Central Division. In addition, we have added material received from the Great Lakes Development Corporation, The Great Lakes Commission and the St. Lawrence Seaway Development Corporation. These organizations in conjunction with the U.S. Coast Guard, NOAA, the Lake Carriers Association and Canada's Seaway Authority, and the International Joint Commision work together to ensure maritime safety on the Great Lakes. Great Lakes mariners provide important weather observations to the National Weather Service.



Canal Park Marine Museum

The Eisenhower Lock (pg. 16), looking westbound, is located near Massena, New York. An early Lakes mariner and an early iron ore transport, circa 1878, are pictured above.

Detroit District, Army Corps of Engineers

used to transport grain from the upper lakes to Buffalo, New York, where it was then transferred to canal boats on the Erie Canal for delivery to New York City. Iron and coal soon eclipsed grain movement. By the late 1700s, Great Britain built the first locks and small boat canals to bypass the rapids on the St. Lawrence and St. Mary's Rivers.

The original Welland Canal, known as Merrit Canal, was completed in 1829 providing a way around the preciptous Niagara Falls. The first lock at Sault Ste. Marie was built in 1855. By 1860, the small St. Mary's Locks were expanded to facilitate direct navigation to Europe via the Erie and Merrit Canals, which had been built between 1825 and 1829. Merrit's Canal, with 40 wooden locks, wasexpanded between 1840 and 1890 and in 1894 the Corps constructed the old Poe Lock on the St. Mary's River.

The Welland Canal expansion in 1844 and the completion of canals and channels by the Canadian Government in 1905, which provided a 14-foot draft, set the stage for the growth of commercial navigation. Lake freighters facilitated the movement of bulk cargoes and

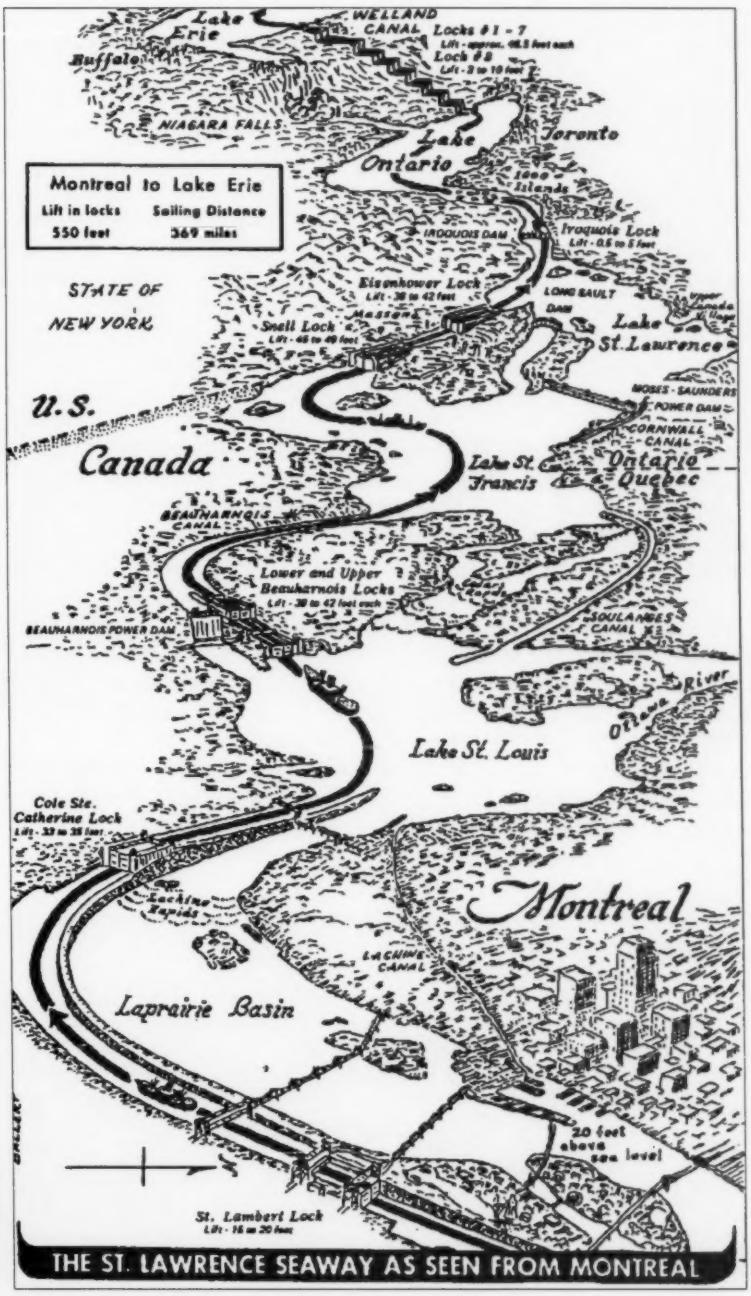
made the system competitive with railroads.

The present Welland Canal is the third major renovation and was constructed by Canada between 1913 and 1932. It has eight locks and could accommodate the lake freighters of that time. However, it was not until the opening of the St. Lawrence section of the Seaway in 1959 that ocean ships began to navigate the system. The Eisenhower and Snell Locks on the St. Lawrence River are similar in size to the Welland Canal and St. Mary's River Locks. One exception is the Poe Lock on the St. Mary's, which can pass through 1000-foot vessels.

The maximum vessel capacity increased from 12,000 tons in the 1920s to 28,000 tons in 1970. In 1971 the ***Stewart J. Cort*** became the largest vessel to transit the locks at Sault Ste. Marie, easing her 1,000-foot x 105-foot frame into the 1,100-foot x 110-foot Poe Lock. By the mid-1970s, 1000-foot long self-unloading carriers capable of carrying 58,000 tons of iron ore began to navigate the system.

Iron ore, coal and grain account for 85 percent of the 220 million tons of waterborne freight carried each year on the waterway.

The role of the U.S. Corps of Engineers in the development of commercial navigation dates back to 1823, when Congress mandated that they become involved in surveying, charting and construc-



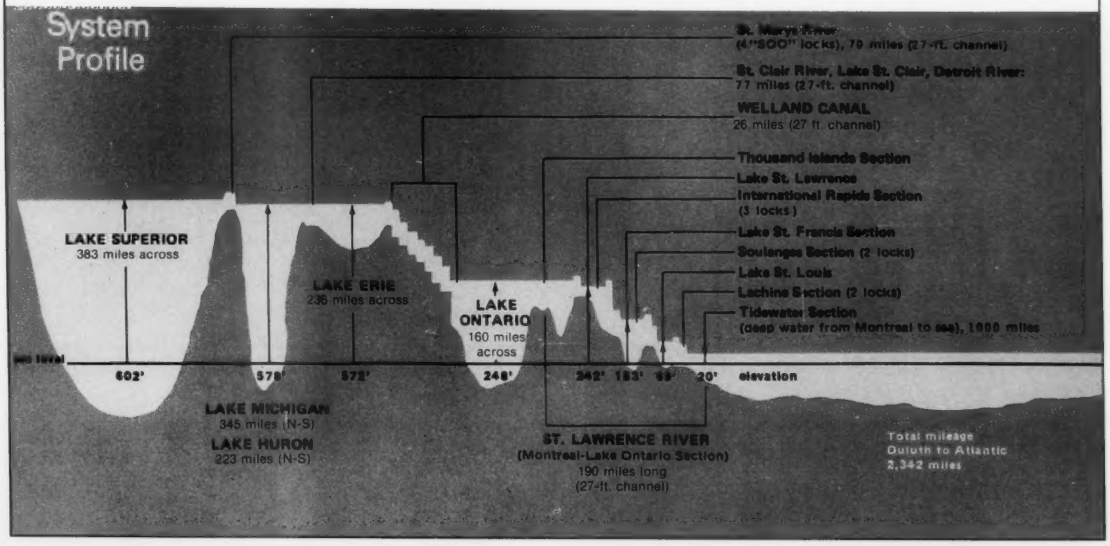
THE ST. LAWRENCE SEAWAY AS SEEN FROM MONTREAL

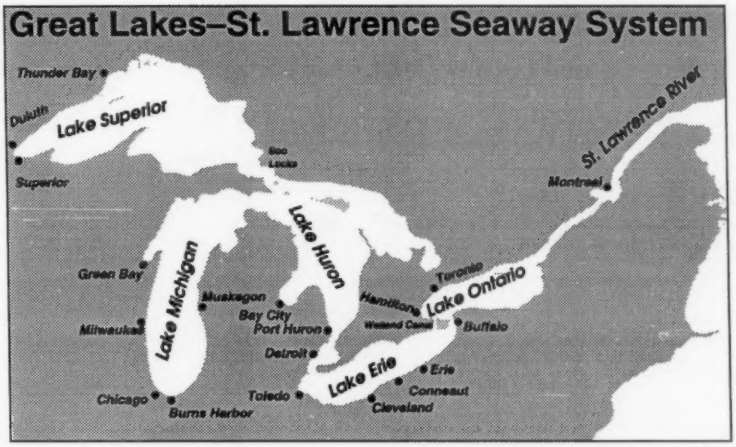
Dr. Albert Ballert's famous view of the St. Lawrence Seaway (above) shows the sailing distance from Montreal to Lake Erie to be 369 miles while the total lift is equal to 550 feet. The old Poe Lock (pg. 17) is seen under construction in September 1894. A new Poe Lock was opened in 1969 and is 1,200 feet long and 110 feet wide. It was built over a period of 7 years at a cost of more than $40 million. To the left is the ***Edgar B. Speer****, one of the many 1000-footers that have navigated the Seaway since the mid 1970s, and one of our Voluntary Observing Ships.*

Great Lakes Geography

The five Great Lakes include Lake Superior, Lake Michigan, Lake Huron, Lake Erie and Lake Ontario. There are 7,870 miles of shoreline and 95,170 square miles of water surface. Because they lie entirely between Canada and the U.S. the Lakes are considered boundary waters rather than international waters.

Free of lunar tides with only light surface currents, the Lakes penetrate deep into the North American continent. Lake Ontario, the smallest of the lakes, is bounded on the north by the Province of Ontario and on the south by New York State. It was named by the Iroquois Indians. With the Welland Canal on one side and the St. Lawrence locks on the other, Lake Ontario is the only one of the Great Lakes which commercial vessels can neither enter nor leave without paying for the privilege. Lake Huron, named for the Huron Indians, is the second largest of the Great Lakes. Bordered on the west by the State of Michigan, and on the north by the Province of Ontario, it includes the large Georgian Bay on the east. Lake Huron, 579 feet above sea level, covers 23,000 square miles and its greatest depth is 750 feet. It is fed from Lake Superior via the St. Marys River, from Lake Michigan, and numerous streams. Lake Erie is the second smallest of the Lakes, bordering the States of Michigan, Ohio, Pennsylvania and New York on the U. S. side and the Province of Ontario in Canada. Erie is the shallowest of the Lakes, with an average depth of only 58 feet and a maximum of 210 feet. Superior, the most northerly and westerly of the Great Lakes, is the largest single body of fresh water in the world. Bounded on the east and north by the Province of Ontario, and on the west and south by the States of Minnesota, Wisconsin and Michigan, the Lake is fed by nearly 200 rivers. Lake Michigan is the third largest of the Lakes and the only one located completely within the boundaries of the U.S. It is bordered on the east and north by the State of Michigan, and on the west and southwest by Wisconsin, Illinois and Indiana. It connects with Lake Huron at the Straits of Mackinac and its greatest depth is 923 feet.





tion on the system.

The Army Corps of Engineers maintains and operates four locks, which it built at Sault Ste. Marie, Michigan. The Corps also constructed the Eisenhower and Snell Locks on the Saint Lawrence, but they are operated by the Saint Lawrence Seaway Development Corporation. All work related to navigation at ports and the connecting channels is supervised by the Corps to assure maintenance of minimum navigable depths. The controlling depth is currently 27 feet.

The Saint Lawrence Seaway Development Corporation is a U.S. government-owned enterprise within the U.S. Department of Transportation. It was created in 1954 to construct the U.S. facilities of the St. Lawrence Seaway navigation project. Since 1959, the Seaway Corporation has been charged with the operation and maintenance of that part of the Seaway between Montreal and Lake Erie, within the U.S., and with the development of the full Seaway system.

With its counterpart agency– the St. Lawrence Seaway Authority of Canada– the Seaway Corporation operates locks and channels, and provides vessels transiting the Seaway, from Montreal to Lake Erie, with traffic control assistance. It also provides and maintains aids to navigation in U.S. waters of the Montreal–Lake Ontario section of the Seaway.

The St. Lawrence Seaway Authority of Canada is a crown corporation that was created by Parliamentary legislation in 1951. Its responsibilities in Canadian waters of the Montreal–Lake Erie section closely parallel those of the Seaway Corporation, and they work together in operating the overall Seaway. The Seaway Authority owns and operates four locks near Montreal, one near Iroquois, Ontario, and eight in the Welland Canal.

In 1990, the Great Lakes Commission celebrated its 35th year as a central figure in management of the Great Lakes. The notion of basin governance–with hydrologic boundaries taking precedence over political boundaries– was anything but commonplace in the early decades of this century. Economic development and environmental protection were largely viewed as mutually exclusive pursuits. The 1950s changed all that as decades of environmental abuse began to take their toll. A seemingly inexhaustible and resilient resource became fragile and finite. Constrained by their own geographic boundaries and the magnitude of the task at hand, states and provinces looked to each other for support and assistance. With the proposed opening of the Seaway, the governors of the Great Lakes states began to act. The State of Michigan led the way by enacting legislation in 1954 authorizing the governor to enter into a compact with its seven sister states and the provinces of Ontario and Quebec. At a Great Lakes/Seaway and Water Resources Conference, officials from the eight states unanimously approved a resolution leading to the development of the Great Lakes Basin Compact.

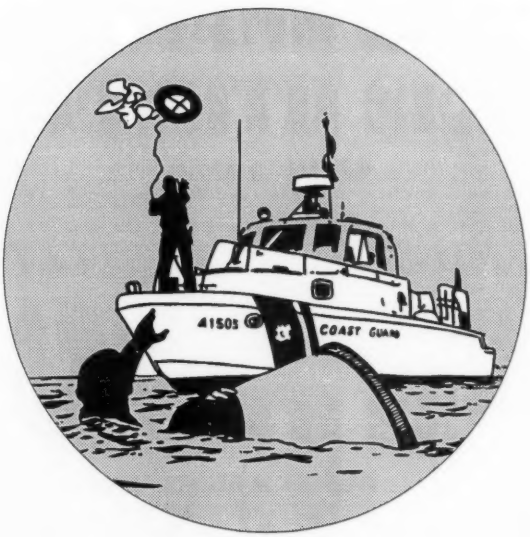
By 1963 Michigan, Illinois, Indiana, Minnesota and Wisconsin, were joined by Pennsylvania, New York and Ohio to complete the Compact. The goal of the Great Lakes Commission is: "To promote the orderly, integrated and comprehensive development, use and conservation of the water resources of the Great Lakes Basin." State delegations of three to five members– including state agency officials, legislators and governor's appointees– comprise the membership.

The Lake Carriers' Association (LCA) was founded in 1880 to represent companies operating U.S. flag bulk freighters on the Great Lakes. Headquartered in Cleveland, Ohio, the LCA has 14 member fleets with a combined vessel roster of 60 ships. LCA-registered vessels account for nearly 98 percent of the tonnage of U.S.-flag Great Lakes self-propelled ships. The LCA promotes the common interests of its members, with a special emphasis on legislative and regulatory matters. Since its founding, the Association has striven to enhance safety and reduce the hazards to Lakes navigation; sought a clean Great Lakes environment while recognizing the needs of commerce; sought adequate harbors and channels; and aided in training of vessel personnel. They have willingly assisted the Voluntary Ship Observation program since its early days.

THE U.S. COAST GUARD ON THE GREAT LAKES

GUARDIANS OF THE EIGHTH SEA

DENIS L. NOBLE



This is a condensed version of: *A brief History of the United States Coast Guard on the Great Lakes*, which appeared in the *Commandant's Bulletin* in March 1989. Additional material was gleaned from a definitive work entitled *Guardians of the Eighth Sea, A history of the U.S. Coast Guard on the Great Lakes*, which was written by T. Michael O'Brien and published by the Ninth Coast Guard District, Cleveland, OH.

As early pioneers and commerce pushed westward through the Great Lakes waterway, the federal government provided four small organizations that helped those who sailed the lakes and maintained a maritime federal law enforcement presence in the old Northwest. Eventually, these four agencies were merged to form the modern-day U.S. Coast Guard.

The U.S. Lighthouse Service was the first of the four agencies that would eventually make up the U.S. Coast Guard on the Great Lakes. The service traces its roots to 1716 with the establishment of a lighthouse on Little Brewster Island, at the entrance to Boston Harbor.

There is considerable debate on where the first light was established on the Great Lakes. A fire in 1920 destroyed many of the service's records. However, F. Ross Holland, the foremost writer on United States lighthouses, sets the 1819 establishment of Presque Isle, on Lake Erie, as the first light in the region. By 1866 there were 72 lights guiding ships to safety, and by the 20th century more than 100

Controversy exists over which was the first Great Lakes light. Presque Isle Light Station (left) at Erie, PA, is considered the first lighthouse, although there is some evidence that it was preceded in 1813 by the Niagara Fort Light on Lake Ontario. This photograph was taken in the 1870s. Below, is Henry Eckford's 1823 drawing of a first-generation, wood-hulled, un-powered lightship. The optic was raised and lowered by block and tackle.

lighthouses dotted the shorelines of the lakes and the St. Lawrence River.

The builders of Great Lakes lighthouses had to contend with storms high bluffs, sandy coasts, shoals, and other problems. These hazards are best illustrated in the establishment of Spectacle Reef Light.

Spectacle Reef, located at the eastern approach to the Straits of Mackinac, was, according to official reports, *"probably more dreaded by navigators than any other danger now unmarked throughout the entire chain of lakes."*

To construct the light a crib dam was built ashore and transported to the reef. The water was removed so the work crew would have a dry location in which to labor. Next, the foundation was leveled and, using 3-foot long bolts, preshaped stones were bolted to the base rock with 21 inches of the bolt sunk into the reef. Then, the courses of stone were bolted to each other and to the layers of stone below. Each bolt was "set in pure portland cement which today is as hard as the stone reef."

During the construction a severe September gale disrupted the work according to one report:

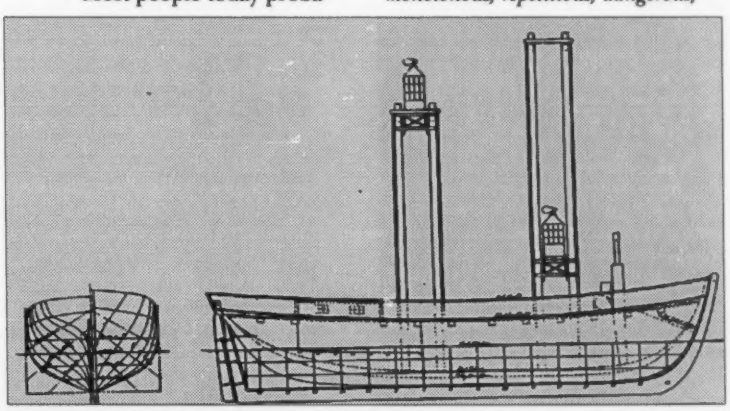
"The sea burst in the doors and windows of the workmen's quarters, tore up the floors and all the bunks on the side nearest the edge of the pier, carried off the walk between the privy and pier, and the privy itself..."

The tower of the light itself is a solid stone mass for the first 34 feet and then rises at least five stories to the top of the structure. It took more than 4 years to complete Spectacle Reef Light. So severe was the winter of 1873 when the keepers came to open the new light, they found ice rafted against the structure to 30 feet in height. This was 7 feet above the entrance, and the men had to chop the ice away before they could seek shelter. The light was officially first exhibited on June 1, 1874.

Most people today probably view the profession of lighthouse keepers as male dominated. However both wives and family members helped in the running of a light. For example, on May 11, 1890, a rowboat capsized in the Detroit River. A passing tug signalled to the keeper of the Mamajuda Light for help. The keeper and his boat, however, were not at the station, so 14 year old Maebelle L. Mason, daughter of the keeper, with the help of her mother, launched a small punt. Then, by herself, the girl pulled for 1 mile and managed to get the exhausted man aboard the boat and then rowed back to the lighthouse. For her rescue, the young woman received the Silver Lifesaving Medal, the second highest award for rescue work.

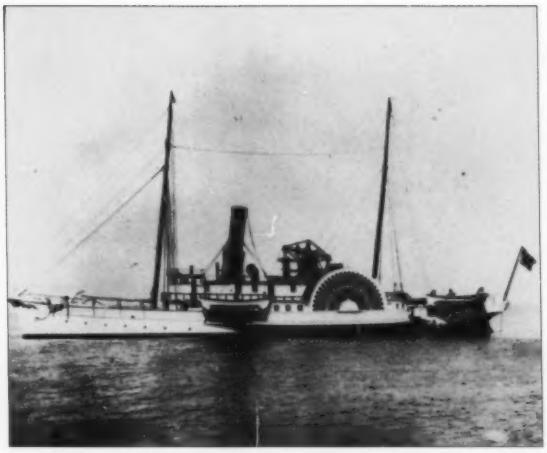
Lighthouses, such as Spectacle Reef, were some of the most isolated stations in the service. The most isolated and dangerous duty, however, was aboard lightships. These small, special ships guarded areas where it was impossible to build a light structure. The obvious danger in this type of duty was that the vessel must remain on station no matter how fierce the gale, plus the ever present danger of being rammed by another ship in thick weather.

The first lightships on the Great Lakes took their stations on Simmons Reef, White Shoal and Gray's Reef in northern Lake Michigan on October 22, 1891. The number of lightships grew to 20 and a total of 18 different stations were occupied. The complement of the small ships was usually one warrant officer and 10 crewmen. In general, their duties were *"monotonous, repetitious, dangerous,*



and above all, lonely."

The U.S. Lighthouse Service also operated another fleet of ships– known as Lighthouse Tenders. The tenders provided the means to bring supplies and needed work parties to the scattered and isolated lighthouses. The locations of lights made this duty hazardous, as lighthouses by their very nature are located in dangerous areas. The first tenders on the lakes were vessels chartered by the Lighthouse Service. In 1874, the ***Dahlia*** was the first tender constructed especially for light ice on the inland seas. She was 141 feet in length, steam powered, iron–hulled, and the first to start the custom of naming this class after flowers, shrubs, trees, or plants.



The U.S. Revenue Cutter ***William P. Fessenden*** *(left) was a sidewheeler type craft that began service on the lakes in 1865. She operated from Cleveland to Detroit. and in 1882 her hull was replaced with an iron one. She was decommissioned in 1903, but placed back in service in in 1905 for 2 years in Florida.*

The next predecessor agency to be stationed on the Great Lakes was the U.S. Revenue Cutter Service. Established in 1790 by the first Secretary of the Treasury, Alexander Hamilton, the service was formed to help combat the loss of revenue by sea–going smugglers. The service operated small cutters and, in 1831, received the assignment of *"winter cruising,"* or performing lifesaving duties on the high seas.

By the 1820's U.S. Revenue Cutter Service cutters were cruising the Great Lakes enforcing revenue laws and assisting lakers in distress. When the winter freeze halted shipping, most of the crew was paid off– except for a small watchkeeping force. The officers, and the ship were laid up.

The Revenue Cutter Service on the Great Lakes had a wide variety of duties. For example, in 1906 the cutter ***Mackinac*** was assigned to Sault Ste. Marie, Michigan, "for customs duty, and to enforce the rules and regulations governing the movements and anchorages of vessels in the St. Mary's River." The cutter's crew, assisted by two launches, carried out this assignment, which became known as the St. Mary's River Patrol. To help in the regulating of traffic, the cuttermen manned six permanent lookout stations located along the waterway. In addition to this assignment, the cutter was also required to patrol local regattas.

The U.S. Life–Saving Service was the next forerunner organization to appear on the Great Lakes. Their mission was to launch small boats in an effort to rescue people shipwrecked close to shore. The service began as a volunteer organization on the Eastern Seaboard. The Federal government entered the picture in 1848 and moved haphazardly until 1854 when a strong storm swept the east coast and many died due to shipwrecks. Congress then authorized more money for the construction of lifesaving stations. By the end of the year, there were 9 boats on Lake Ontario, 14 on Lake Erie, 23 on Lake Michigan, and 1 on Lake Superior. These boats were generally placed at light stations.

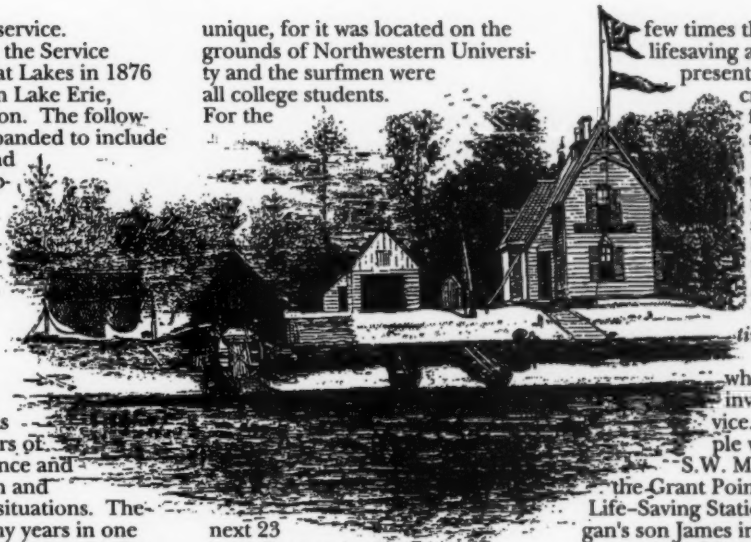
The winter of 1870–1871 on the Great Lakes was harsh. More than 214 died in maritime related accidents and the Life–Saving Service came under fire for its poor performance. Sumner Kimball, was appointed to head the service and managed to reshape the organization, dramatically improving the

reputation of the service.

Officially, the Service began on the Great Lakes in 1876 with 11 stations on Lake Erie, Ontario, and Huron. The following year it was expanded to include Lakes Superior and Michigan. As shipping increased, so did the need for more stations until, by 1914, there were 62 stations scattered throughout the lakes.

The station's supervisor, officially known as a keeper, had years of maritime experience and could handle men and boats in difficult situations. The keeper spent many years in one area, becoming an expert on the weather and surf conditions. Furthermore, because surfmen were chosen from the local community, the stations remained principally a local affair. This is one of the main reasons behind the strong bond that now exists between the modern day U.S. Coast Guard and the municipalities that dot the Great Lakes shorelines.

One of the best examples of the old U.S. Life-Saving Service keeper and his bond to a local area is Lawrence 0. Lawson of the Evanston, Illinois, Station. Lawson was born in Sweden, but after working on Baltic Sea ships for a time, he emigrated settling in Chicago and pursuing a living as a fisherman. On July 12, 1880, he was appointed the keeper of the Evanston Station. The station was unique, for it was located on the grounds of Northwestern University and the surfmen were all college students. For the next 23 years Lawson instilled in his crews *"a sense of responsibility, faithfulness and courage."* One memorial to the keeper states that under *"his superb leadership 447 persons were rescued from more than 35 shipwrecks..."*



Arguably the greatest and most difficult rescue of Lawson's long career came on November 28, 1889, when the steamer ***Calumet*** foundered off Fort Sheridan. The entire Evanston crew, and their boat, were transported by rail to the location. They had to wrestle the boat down a steep bluff to the beach, face a howling gale, towering waves, and sleet to reach the shipwreck. For their rescue of the 18 crewmen of the ***Calumet***, the entire Evanston crew received the Gold Lifesaving Medal, one of the few times that the highest lifesaving award has been presented to an entire crew. Lawson finally left the service on July 16, 1903. At the time of his retirement one writer aptly summed up the old lifesaver: he *"set standards and traditions that will last a lifetime."*

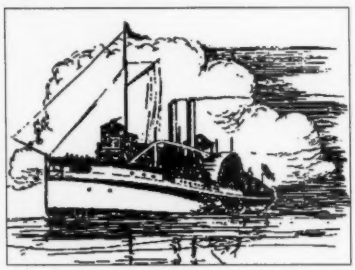
Sometimes whole families were involved in the Service. One such example was the family of S.W. Morgan, Keeper of the Grant Point au Sable Life-Saving Station. Keeper Morgan's son James interrupted his own successful maritime career to become the number 1 surfman on his father's crew before being appointed Keeper of the Manistee Station. The pair were involved in many a heroic rescue, but it was Edith Morgan, the elder Keeper's daughter and Jame's younger sister, whose heroism on two occasions earned the Silver Life Saving Medal.

The job of surfman was dangerous and low-paying. The accounts of their heroic deeds could fill volumes. A brief passage from the Service's annual report of 1883, lauding the efforts of the Grand Point au Sable crew on November 24th is a typical account of the duress that these men and women often encoutered: *"The labors of the life-saving crew upon this date seem particularly worthy of honorable comment. They performed the remarkable service of saving life from two wrecks in succession with the same apparatus working...with wet and frozen lines, which it required peculiar skill and judgement to handle effectively. To achieve this end involved a severe trudge..., of thirty-four miles, trundling with the aid of half-blown horses, a heavy wagon..., through a rough wilderness of brush and sand and blasts of snow. The...setting up hawsers and hauling lines, and dragging upon them in the drench of icy surf..., becomes a mere incident to the savage toils of such a journey."*

At right, is the crew of the Evanston, IL U.S. Life-Saving Station. Keeper Lawrence O. Lawson, center row, facing left, was in charge of this station from 1880 to 1903. The entire crew earned the Gold Lifesaving Medal for their rescue of the Calumet during a sleet storm on November 28, 1889.

THE STEAMBOAT INSPECTION SERVICE

The last of the four predecessor agencies to eventually form the U.S. Coast Guard on the Great Lakes was The Steamboat Inspection Service. It came about due to the large growth of steam powered ships and the resultant explosions of faulty boilers with great loss of life. The mounting death toll led to the passage of the first laws, in 1838, to regulate passenger carrying steam vessels.



In the early years of steamboat development, inland waterways were better suited to the new vessels than ocean navigation. The waters of the Great Lakes, of course, were ideally suited to this new type of propulsion. The Steamboat Inspection Service grew in fits and starts with the service usually gaining more responsibilities after a marine disaster. By 1911, the organization listed as their duties: the inspection of vessel construction and equipment; the examination and licensing of marine officers; the examination of seamen and investigations of marine casualties and violations of inspection laws; establishing regulations for the transporting of passengers and merchandise.

There were two Steamboat Inspection Service Districts in the Great Lakes: the Eighth included all the waters north and west of Lake Erie and the Ninth, which encompassed the St. Lawrence River, Lake Erie, Ontario, and Champlain. Headquarters for the Eighth was in Detroit, Michigan and the Ninth District headquarters was located in Cleveland, Ohio.

In an effort to streamline operations, on January 15, 1915, the U.S. Revenue Cutter Service and the U.S. Life-Saving Service were combined to form the U.S. Coast Guard.

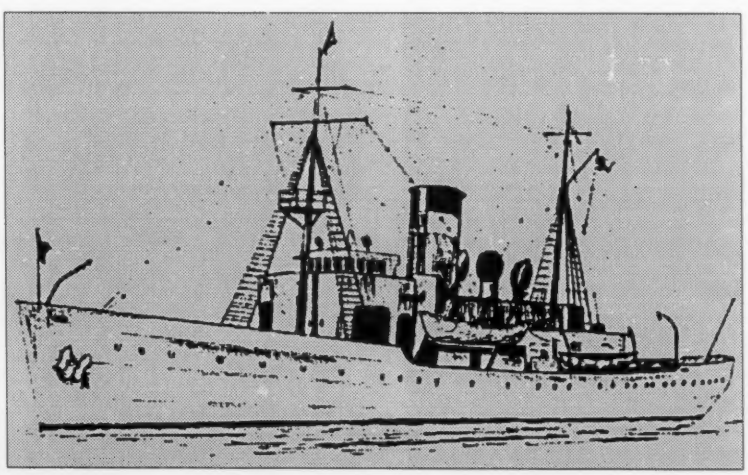
At first glance there seemed to be little difference between the new service and its predecessors. Cutters still performed their traditional duties, the St. Mary's River Patrol still operated during shipping season, and small rescue boats continued to put out into storm tossed lakes to rescue those in distress. Indeed, in November 1919, during a strong gale, with the temperature hovering at 18°F, the rescue of the ***H.E. Runnels*** near Grand Marais, Michigan, was a feat that one historian noted was *"worthy .... even by the standards of the old Life Saving Service ..."* There were, however, large changes on the horizon.

The first major task of the new service came in 1920 with the passage of the Volstead Act, the experiment to outlaw liquor in the United States. For the next 14 years the U.S. Coast Guard waged a war against the smugglers of illegal spirits. With easy access to Canada, smugglers had a field day. Illegal activity on the lakes reached its zenith during the fall of 1927 and the spring of 1928. To combat the rum runners, station crews were doubled, patrol boats were increased, and a 75-foot picket boat class was added to the Coast Guard's inventory. However, the flow of liquor was never completely stopped and only the passage of the 21st Amendment, the repeal of Prohibition, brought the rum war to a close.

The 1930s not only marked the end of Prohibition, but also ushered in the beginnings of new technology for the U.S. Coast Guard on the Great Lakes. In 1932, a new class of cutter was constructed at the DeFoe Works, Bay City, Michigan, and the first was christened the ***Escanaba***. She was 165 feet in length and powered by a 1,500 horsepower steam turbine. On December. 9, 1932, the cutter was assigned to her homeport of Grand Haven, Mich. The ***Escanaba*** was designed to help keep shipping lanes open as late as possible.

In 1939, as war clouds began to thicken, President Franklin D. Roosevelt made another major change to the U.S. Coast Guard as the U.S. Lighthouse Service was added. Shortly after this, the service itself became part of the U.S. Navy as the nation prepared for World War II.

The Great Lakes assumed an even greater role as a transportation artery during World War II. It then became an important part of the war effort for the Coast



*The **Escanaba** (below, left) was assigned to Grand Haven, MI in 1932. When she sank in June 1943 only two of her crew survived. Sketch by Larry Van Alstyne. The lightship **Huron** (right) was the last of her type on the Great Lakes. Replaced by a horn buoy, she left her station on August 21, 1970. The former lightship is now a museum in Port Huron's Pine Grove Park.*

Guard to keep shipping moving as late as possible and to guard against sabotage. Coast Guard personnel guarded shorelines, docks, vessels and bridges, patrolled harbors, and manned lookout stations to protect vital shipping. In 1942, as a wartime measure, the Steamboat Inspection Service, now called the U.S. Bureau of Marine Inspection and Navigation, was transferred to the U.S. Coast Guard. The transfer was made permanent in 1946. In order to keep shipping moving as long a possible, $8 million was appropriated to build an icebreaker for Great Lakes use. The 290-foot ***Mackinaw*** was launched and commissioned on March 4, 1944, the most powerful icebreaker in the world at the time for her designed purposes.

At the outbreak of World War II, some cutters were transferred to help in the Battle of the Atlantic. One of the cutters making the move to the Atlantic was the ***Escanaba***. In June 1943, while operating with a convoy out of Narsarssuak, Greenland, Seaman First Class Raymond O'Malley, at 5:10 in the morning, heard *"a noise which sounded like three of four bursts of 20 mm machine gun fire."* Within minutes, there was a tremendous explosion that ripped the cutter in two. Only two men survived, O'Malley and Boatswain's Mate Second Class Melvin Baldwin. The citizens of Grand Haven, to pay tribute to the men who died, established a memorial park and raised more than a million dollars in U.S. war bonds to build another ship to bear the name ***Escanaba***. Since World War II, Grand Haven has held the U.S. Coast Guard Festival in August of each year.

The U.S. Coast Guard that emerged from World War II is basically the service that still operates today. To be sure, there have been major changes. Technology, for example, has made it possible to close many units and automate lighthouses. Spectacle Reef Lighthouse, the great engineering feat of the 19th century, for example, was automated in 1972. The last lightship on the Great Lakes, the ***Huron***, was replaced by a lighted horn buoy and radio beacon on August 21, 1970. Also, the number of small boat stations has been greatly reduced by changing technology, including Keeper Lawrence O. Lawson's old Evanston, Illinois unit. Among the biggest reasons for these reductions were the development of helicopters as a rescue tool and the addition of more air stations on the Great Lakes. In 1966, a new air station was opened near Detroit and equipped with Sikorsky HH52A helicopters. This "chopper" has a top speed of 125 mph. It was designed to pick up an injured person either by rescue hoist or by landing in the water, and then return to base with a safe margin of fuel remaining. In its first year of operation, this station is credited with saving 330 lives.

Like the old U.S. Revenue Cutter Service, the U.S. Coast Guard still continues to perform a multitude of duties on the Great Lakes. In the 1960s, after lifesaving, icebreaking, to keep the shipping lanes open as long as possible was one of the larger missions. Beginning in mid or late December, three operations were usually underway to accomplish this duty: *Taconite*, centered mainly in Whitefish Bay, the St. Mary's River, and the Straits of Mackinac, designed to keep the ore boats moving from Minnesota to Gary, Indiana. *Coal Shovel*, along the south shore of Lake Erie to Detroit, kept the coal supply moving to factories in Michigan's largest industrial city: *Oil Can*, assisted tankers in the Green Bay, Wisconsin, and Grand Traverse Bay, Michigan, region.

A typical day in today's Coast Guard illustrates its diversity. In 1990 an average day included saving 11 lives, assisting 334 people, conducting 226 search and rescue sorties, responding to 23 oil or HAZMAT spills, conducting 90 port safety/security operations, inspecting 93 commercial vessels. investigating 26 marine accidents, servicing 117 aids-to-navigation, seizing 148 pounds of marijuana and 83 pounds of cocaine, and saving $3 million in property. In addition Coast Guardsmen take more than 500 regular weather observations at stations and aboard vessels—all in one day.

Tibbetts Point Lighthouse

Elinor DeWire

There was a time when only lightkeepers and their families knew what it was like to live at a lighthouse. The rest of us had to be content with romanticized stories of treacherous storms and shipwrecks, pea-soup fogs, ghosts, pirates, and daring rescues. But today, with many lighthouses open to the public as museums and centerpieces of parks, all that has changed. A new kind of lighthouse keeper has emerged– with a title such as curator, caretaker, host, or site manager–who will help us recapture the bygone days of wooden ships and the lights they steered by.

Of the more than 100 lighthouses in the U.S. now open to the public, almost all are accessible only during daylight hours. Lighthouses, however, are much more impressive after dark. Probing the night with their silent piercing beams and sounding a doleful warning through the fog, they reveal the true picture of lightkeeping as a largely nocturnal vocation.

Tibbetts Point Light (above) is 69 feet above water. The old foghorns are still visible (right) and the small square lighthouse is now a welcoming landmark (page 31). All photos by Elinor DeWire and the sketch was kindly provided by Paul Bradley.

At Tibbetts Point Lighthouse on the Lake Ontario end of the St. Lawrence Seaway, visitors can stop by the old station during the day, but it's more fun to spend a night at the light. Tibbetts Point is a lighthouse hostel operated by the Syracuse Council of American Youth Hostels, Inc. It opened just 6 years ago in the two keepers houses next to the lighthouse, which is still an active navigational aid. Facilities are spartan and homey, but very affordable considering the unique setting. Tibbetts Point Lighthouse Hostel is one of only a half dozen lighthouses in the nation offering overnight accomodations and the experience of living at a lighthouse.

Hostel manager, Tom Kenny, resides at the station from May to October, keeping the grounds and buildings shipshape and entertaining guests with his stories about the lighthouse and the history of the region. Caesar, the hostel's friendly, cold-nosed, watchdog, tags along everywhere Kenny goes. and never misses a chance to ham it up for the camera. When it was time to leave the hostel, he escorted the author to her car and tried to jump in!

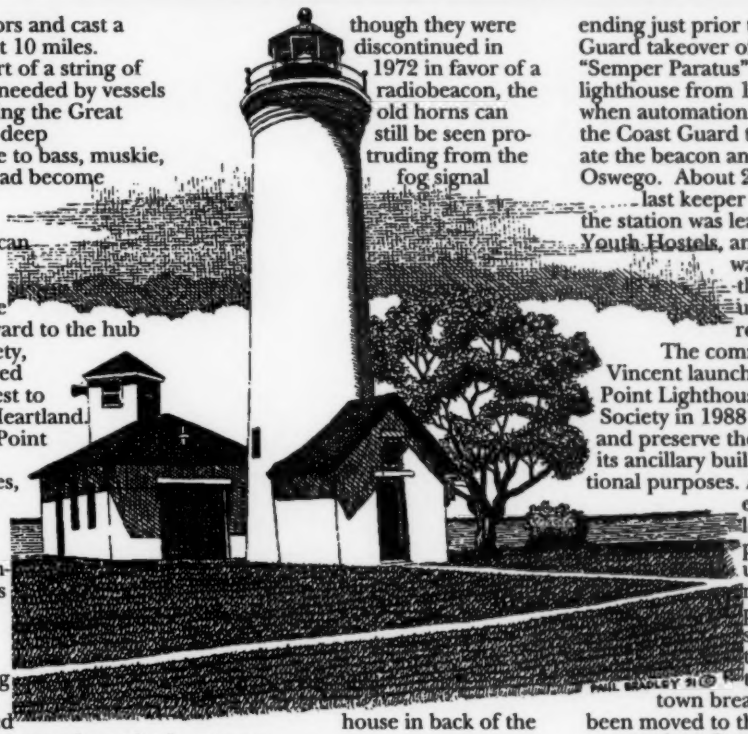
Tibbetts Point Lighthouse sits on scenic Cape Vincent, New York, looking across islands like Wolfe, Grenedier, and Carleton to the shores of Ontario. The point was named for Captain John Tibbett of Troy, New York who owned 600 acres here in the 18th century. In 1827 the U.S. Government obtained three acres of the Tibbett land and built a stone lighthouse to mark the entrance to the St. Lawrence River. It was illuminated with whale oil

lamps and reflectors and cast a beam visible about 10 miles. The tower was part of a string of beacons urgently needed by vessels entering and leaving the Great Lakes. these rich, deep blue waters—home to bass, muskie, trout, and pike—had become important shipping routes following the American Revolution. Grain, lumber, coal, and ore were transported eastward to the hub of American society, while manufactured goods traveled west to the burgeoning Heartland.

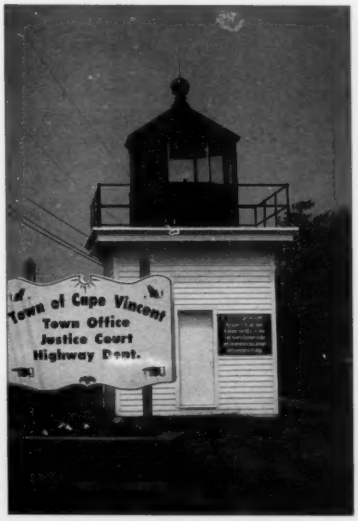
Tibbetts Point Lighthouse, like others on the lakes, showed a beacon from April to December then closed for the winter. Great chunks of ice piled up around it in January and February, creating a glistening spectacle that attracted brave winter sightseers who arrived by sleigh or walked over the ice. After a storm the lighthouse sometimes became encased in ice from top to bottom with long icicles hanging from its lantern like the magnificent spires of a cathedral. In the spring, when the jam began to break up, the clamor of grinding and gnawing ice could be heard miles inland.

In 1854 the old lighthouse was demolished and the present 69-foot masonry and stucco tower was built. A beautiful Fresnel lens was purchased for it from Paris to be used with oil lamps. It exhibited a fixed white light of fourth order. After electrification in the 1930s, Tibbetts Point Light was changed to a flashing signal, turned on for six seconds and eclipsed for 4 seconds.

A steam fog whistle was installed in 1896 operated by a coal-fired, compressed air boiler. Thirty years later the fog signal was converted to two diaphone horns run by a Diesel engine. Their mournful groan could be heard about 5 miles, and though they were discontinued in 1972 in favor of a radiobeacon, the old horns can still be seen protruding from the fog signal house in back of the tower.



Tibbetts Point Light has had many keepers in its long career. The Montonna family are the most remembered, having tended the station more than 50 years beginning in the 1880s and ending just prior to the Coast Guard takeover of the station. "Semper Paratus" resided at the lighthouse from 1939 until 1981 when automation arrived, allowing the Coast Guard to remotely operate the beacon and foghorns from Oswego. About 2 years after its last keeper was transferred, the station was leased to American Youth Hostels, and Tibbetts Point was again occupied, this time as a unique vacation retreat.



The community of Cape Vincent launched the Tibbetts Point Lighthouse Historical Society in 1988 to help restore and preserve their lighthouse and its ancillary buildings for educational purposes. A group of seventh graders at a local school pitched in to clean up the grounds, mow grass, and paint. The small square lighthouse that once stood at the end of the town breakwall and had been moved to the southern approach to Cape Vincent was spruced up and made a welcome landmark.

Society member Shirley Hamblen has aroused tremendous support for the lighthouse restoration project, which includes plans to install an exhibit hall featuring the history of the region and the light's important role as a Great Lakes sentinel. She enthusiastically steers visitors from her gift shop in Cape Vincent—stocked with all manner of lighthouse memorabilia— to the spot where Tibbetts Point Lighthouse stands its watch. If visitors can't stay the night, she advises them to take in the sunset looking west over Lake Ontario. It's the next best thing to having the lighthouse beam sweep over a bedroom window at night.

For information on Tibbetts Point Lighthouse Hostel, write RR1, Box 330, Cape Vincent, NY 13618 or call (315) 654-3450. The hostel is open from May 15-September 15 and reservations are required.

f/Stops vs. Speed

Michael Halminski

There are two factors that determine the proper exposure of film. One is shutter speed, an aspect I touched upon in my last article. The other is called lens aperture or f/stop. A photographer can easily manipulate these variables to achieve the best possible image.

As a photographer adjusts the f/stop, he changes the size of the lens opening through which light enters the camera. The aperture works like the pupil of the eye. It may be enlarged or contracted according to the light requirements of the film. Apertures that are lower in number such as 1.2, 2 or 2.8 for example, let in larger amounts of light, while those larger in number, like 16, 22 or 32 allow smaller amounts of light (these represent fractions).

The photographer can select any combination of shutter speed and aperture that properly exposes the film. The order of numbers in referring to f/stops and shutter speeds is no coincidence. Each succeeding f/stop marked on the lens cuts the amount of light in half. That is, f/5.6 allows half the quantity of light as f/4. Correspondingly, each increase in shutter speed does the same thing. For example, a $\frac{1}{500}$ of a second is half the amount of $\frac{1}{250}$ of a second. So the two can be worked together simply– as the shutter speed increases, lens aperture also increases in size. As an example, the same exposure is made at f/8 at $\frac{1}{250}$, as f/11 at $\frac{1}{125}$ of a second, or f/16 at $\frac{1}{60}$ and so on.

Aperture changes can have big effects on focus. As aperture size gets smaller, more of the background and foreground in a scene becomes sharper. This zone of sharpness is known as depth of field. Determining the depth of field is relatively simple with most cameras. Lenses are usually marked with a depth of field scale. This is used in conjunction with a focusing scale, and reads the distances from the film plane that will be in sharp focus. Another way is to hit your depth of field preview button, if your camera is so equipped, and see it right in your viewfinder.

A trademark of the great landscape photographers is that extra sharp , crisp detail from foreground to background. This is achieved by stopping down the lens to a small aperture, while at the same time adjusting to a longer shutter speed to get the right amount of light for proper exposure. This often requires the support of a steady tripod.

A few years ago, I had the opportunity to pass through the Panama Canal aboard the 70–foot sloop, Challenge. To shoot a photograph, I stood on the bow with a 135 mm lens stopped down to f/11 at $\frac{1}{250}$ of a second. I focused sharply on the opening gate in the foreground, and managed to maintain a reasonable depth of field right up to the approaching ship in the distance. If I had used an exposure of f/5.6 at $\frac{1}{100}$ of a second, the ship would have appeared more out of focus. With an exposure of f/22 at $\frac{1}{60}$ of a second, the ship would have been even sharper. However, hand holding a camera at this setting might have produced a blurred image from any slight movement, like breathing or pressing the shutter.

Michael Halminski

The photograph was taken in the Panama Canal. Michael was aboard a 70–foot sloop, so he had to give important consideration to the shutter speed in order to keep the picture from being a blur. This tends to limit the aperture opening and hence the depth of field or range that objects appear in focus. There are certain times when you might want to deliberately limit the depth of field in order to place special emphasis on a particular subject. This can be done with the aid of information on the camera itself.

This shot of two whales was submitted by Captain Karun Chhabra, Master of the m.v. Santa Marta of Dole Fresh Fruit International, Ltd. The whales were sighted in the Florida Straits near 28°08'N, 79°51'W on August 14, 1991 at about 2115 UTC.

Charles Brown

*Charles Brown, Radio Operator aboard the **S.S. Guadalupe** (KSHF) took this panoramic view of the fringes of Hurricane Klaus on October 7, 1990. They were at anchor in the early morning as the sun came up and Klaus was to the east of them over the Virgin Islands. Backlighting provided several dramatic views for a few minutes only, as Charles noted. This is often the case with natural lighting. Many professional photographers wait hours or even days for the right lighting conditions. The **S.S. Guadalupe** was off Las Mareas, Puerto Rico. The hurricane curved around them and they were, fortunately, not affected.*

Portrait of the *S.S. Guadalupe*

In addition to the good photograph above, Radio Officer Charles Brown was also kind enough to send us a profile of his vessel. The Tanker ***S.S. Guadalupe*** is owned by Sabine Towing and Transportation and was named after a river in Texas. The ship (right) is 683 feet in length and is designed with 30 tanks with about 47 feet from the top of the deck to the bottom of the tank. When fully loaded, its draft is 33 feet. It carries 240,000 barrels and has a normal speed of 13 to 14 knots. Cargo is generally petrochemicals, orthoxylene, naptha, paraxylene and cyclohexane. Their ports of call are Houston TX, Savannah GA, Wilmington, NC and Las Mareas, PR. They copy high frequency weather facsimile and Mobile, AL (WLO) radio SITOR. There are normally 25 people on the vessel and they are out approximately 75 days at a time.

Charles Brown

S.S. Guadalupe

How has Opening the Seaway Introduced Alien Species into the Great Lakes?

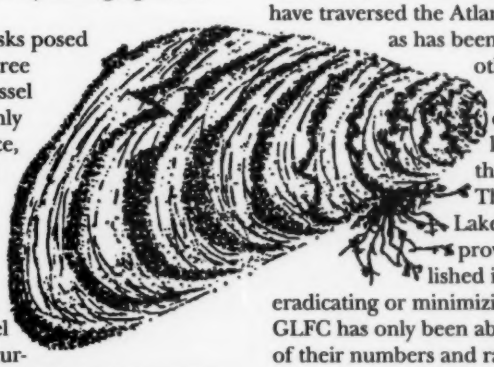
Margaret Dochota
Great Lakes Fishery Commission

This article originally appeared in the January–March, 1990 edition of ***Seaway Review*** *. It was entitled "Controlling Alien Fish Species in the Great Lakes" and answers the question quite well. We appreciate their help.*

–ed.

Although ballast water was presumed responsible for certain marine species introductions in the Great Lakes over the years, such introductions were largely innocuous and difficult to attribute with certainty to ballast water of ocean-going vessels. Three recent European arrivals (the ruffe, spiny water flea and zebra mussel) are different, however, and could be very damaging to the ecosystem.

There are potential risks posed to the Great Lakes by these three recent arrivals. The zebra mussel (*Dreissena polymorpha*) can firmly attach itself to any solid surface, such as spawning reefs, boats and water intake pipes, impairing their use. Its filter feeding may remove algae from the water, thereby impacting food chains at the lowest level. The zebra mussel is spreading rapidly from its current range in Lakes St. Clair and Erie, and threatens to be very costly to industries and cities that draw their water from the Great Lakes.

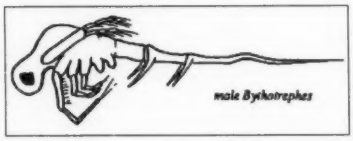


The probable impact of the spiny water flea (*Bythotrephes cederstroemi*) remains the subject of study and debate among scientists. As a predaceous planktonic crustacean preying on smaller organisms such as *Daphnia*, the spiny water flea has the potential to reduce the food supply for larval fish and to reduce water clarity by sparing algae from grazing. The spiny water flea has been found throughout the Great Lakes.

The ruffe (*Gymnocephalus cernuus*), a European relative of the perch, has little sport or commercial value. It can rapidly dominate yellow perch populations through competition with small perch. In Europe the ruffe preys on the eggs of whitefish, significantly depressing its abundance in some instances. Like the zebra mussel and spiny water flea, the ruffe is very prolific. Its range is currently restricted to the western end of Lake Superior. It is difficult to conceive how, other than in ballast water, the ruffe could have traversed the Atlantic– certainly not on bird's feet as has been suggested for some of the other exotics.

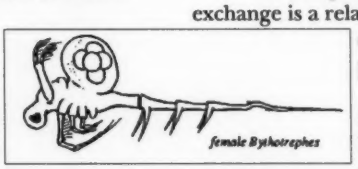
The potential for eradicating exotic organisms, once established in large systems such as the Great Lakes, is next to nil. The experience of the Great Lakes Fishery Commission(GLFC) provides a good example. Established in 1955 with responsibility for eradicating or minimizing the exotic sea lamprey, the GLFC has only been able to achieve reasonable control of their numbers and range.

Thus, with exotics the best medicine is prevention. One of the reasons the role of ballast water in transporting organisms was not appreciated earlier is because the water is taken on and (for the most part) discharged below the waterline. Ocean-going ships carry as much as 1.25 million gallons of ballast water, when they are travelling without cargo.



In the last 10 years, as many as 1,100 ocean-going vessels have entered the Great Lakes annually, almost all of which carried ballast water. As many as 600 a year were *in ballast*, that is, carrying water in place of cargo.

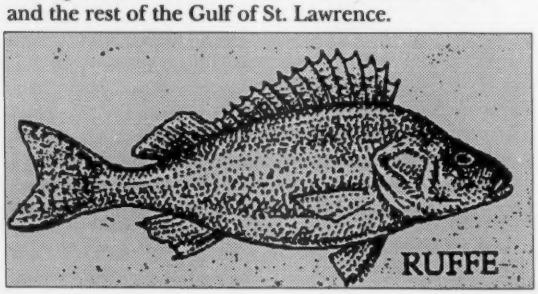
Researchers believe that the zebra mussel was introduced into the Lake St. Clair system in 1986, and the ruffe into Duluth harbor in 1983. The spiny water flea was first noted in Lake Huron in 1984, but when and how frequently it was introduced before then is difficult to determine.



The most effective effort to date to prevent further introductions of harmful exotics has come through the U.S. and Canadian Coast Guards, acting under the 1987 Water Quality Agreement between Canada and the U.S.

The Canadian Coast Guard, in consultation with the U.S. Coast Guard, St. Lawrence Seaway officials, shipping associations, Fisheries and Oceans Canada, Environment Canada and the Great Lakes Fishery Commission, has established voluntary guidelines effective May 1, 1989 which request that ships entering the Seaway first exchange their ballast off the continental shelf (i.e. depths greater than 2000 meters).

If this is not possible for reasons of safety or because coastal ships have not left the shelf, the ballast water may be exchanged in the Laurentian Channel in the Gulf of St. Lawrence. Prior to the 1990 shipping season, Fisheries and Oceans Canada will review exchanging ballast in the Gulf. It is believed that little mixing occurs between Laurentian Channel waters and the rest of the Gulf of St. Lawrence.



Ships' masters are expected to confirm the exchange in writing, and the Coast Guard has agreed to spot test incoming ballast water.

The primary objective in exchanging nearshore ballast water for open ocean water is not to increase salinity. All but 4 percent of unchanged ballast has been found to contain some salt already, and many coastal organisms are tolerant of both salt and fresh water. Rather, it is to exchange coastal organisms for those which are less likely to survive and reproduce in the Great Lakes due to their intolerance of freshwater, adaptation to open water, and relative lack of abundance in terms of both species an absolute number.

An important point is that mid-ocean ballast exchange is a relatively safe and cost-effective procedure, occasionally practiced by shippers for their own purposes.

The Great Lakes are not alone in experiencing a recent onslaught of harmful ballast water-mediated introductions. Caged salmon in Norwegian waters were threatened by toxic algae transported by ballast water.

California is being invaded by large numbers of Asian organisms transported by ocean-going vessels which can carry even more ballast water than those ships visiting the Great Lakes. Australia has required by regulation that ships exchange ballast water because red tide organisms were being imported into her waters.

Throughout the world we are learning that the damage effect by exotics more than warrants the simple preventive ballast exchange procedures now being requested of shippers.

The Zebra Mussel Information Clearinghouse was established by New York Sea Grant to collect and distribute information about the zebra mussel in a variety of formats to a basinwide audience. The Clearinghouse has an extensive collection of scientific and technical literature relevant to the zebra mussel. Reports on current and proposed research are available. A map of confirmed sightings of the mussel is maintained and updated at least every 2 months.. The Clearinghouse publishes brochures and fact sheets as well as a bimonthly newsletter. For more information please contact:

Zebra Mussel Clearinghouse
250 Hartwell Hall
State University of New York
Brockport, NY 14420

Awards and PMO News

R/V *Lake Guardian*

The R/V ***Lake Guardian*** is the U.S. Environmental Protection Agency's newest, cleanest and largest surveillance and monitoring vessel. A former offshore oil-field supply vessel, it will conduct in-depth studies of water quality in the Great Lakes and connecting channels. The ***Lake Guardian's*** mission is to gather information about chemical and biological conditions of the lakes and to monitor the pollutant concentrations in water, sediments air, fish, and other biological material. The vessel is 180 feet long, weighs more than 1,700 tons and is home to a crew of 11. More than 1,000 schools in the Great Lakes Basin helped name this vessel, which will be based in Bay City, MI. From this central location it will be able to conduct activities year round, accommodating up to 31 additional scientists for monitoring cruises and research activities. We are looking forward to its participation in the VOS program.

Great Lakes Marine Weather Newsletter

This semi-annual newsletter is published by the National Weather Service to keep the Great Lakes marine community abreast of ongoing developments in the Great Lakes Marine Weather Enhancement Program and to discuss related items of interest. They are always looking for items of interest and input on specific topics you might like to see discussed. They can be contacted at

National Weather Service,
Cleveland Hopkins International Airport,
Federal Facilities Building,
Cleveland, OH 44135
telephone (216) 267-3900

In their latest issue they mention that the forecasters at the Weather Service Forecast Office, Cleveland, are working on new theories of waterspout formation and forecasting, and are trying to build a database of eyewitness reports. If anyone has seen a waterspout or funnel cloud on the Great Lakes, please send or call free of charge with the specifics of the sighting, mainly location, date and time of day. If you have pictures of these phenomena, they of course would be grateful if you could send the negatives, which will be returned.

*The R/V **Lake Guardian** is equipped with highly sophisticated analytical instrumentation, six oceanographic winches for sampling equipment and three permanent laboratories.*

Getting to Know Your PMO

Ronald W. Fordyce, PMO Toronto

MWL: Compare the U.S. and Canadian PMO programs.
Ron: Basically, the Canadian program is similar. Our PMOs differ in that we are involved in a lot more than just ship visits. We install and maintain all the marine equipment put aboard the vessels, including the wind monitoring system. We are also heavily involved in the weather buoy and automatic weather station programs. On the Great Lakes we manage five 3–meter buoys and a number of automatic weather stations located at lighthouses and other locations.

MWL: How large is your Great Lakes program?
Ron: The Canadian VOS program has 105 participating ships, all of which are fully equipped with all instruments, including wind monitoring systems. The fleet has changed over the last few years and now a large portion of the new tonnage not only trades on the Great Lakes, but can go deep sea.These ships provide us with about 25,000 to 30,000 observations each season.

MWL: Is their much interaction between programs?
Ron: Most of our contact is with George Smith. George and I talk regularly and attend meetings together, such as the International Ship Masters Convention, where we make presentations about our respective programs. I'm not forgetting Bob over in Chicago– we also keep in touch. We do have some contact with your PMOs along the Eastern Seaboard and the Gulf of Mexico, who visit our ships when they trade at their ports.

MWL: How large is your territory?
Ron: We cover the Great Lakes and the larger inland waters such as Lake of the Woods and Lake Simcoe. Our office is located in Burlington at the National Water Research Institute, which is central to the high density ship traffic centers. Our busiest ports are Hamilton, Nanticoke, the Windsor to Sarnia corridor and Thunderbay. We are also located close to the Welland Canal, where we make most of our visits. It takes 12 to 14 hours, depending upon weather and traffic, for a ship to transit the system, which gives us ample time to make our visits.

MWL: What is the source of your observations?
Ron: Most come from the Great Lakes Carriers. Salties that transit the Great Lakes System on a regular basis will participate, but to a lesser degree than the Canadian fleet. Usually ocean ships have their hands full just navigating and trying to figure our weather, especially in the fall and early spring. One of the largest contributors is the Canadian Coast Guard. I'm proud to say that one of their ships, the ***Samuel Risley***, provided just under 3,000 observations in 1990.

MWL: How long have you been involved in weather?
Ron: I have been in this business for 26 years. I started back in 1965 in Toronto and have worked in many areas such as briefing, research and training. I have been a PMO for the past 12 years and have just recently been promoted to Superintendent, Marine Data Unit for the Ontario Region. Incidently we have just added two new PMOs to the elite PMO family on this continent– Rich Shukster and Keith Clifford, who will also be working out of Burlington.

MWL: How about your family?
Ron: I'm married –22 years this thanksgiving– I have two sons. Kregg is the oldest; he's 19 and is attending the University of Waterloo, and Kameron, who is 18, is in his last year of high school. My wife's name is Sharron and she works part time for Niagara College here on the peninsula.

MWL: Any hobbies?
Ron: I suppose boating is at the top of the list. We have a cuddy cab boat which we keep on Lake Erie. It keeps the entire family active during the summer months. I also like to fish, hunt and play golf.

Canadian Port Meteorological Officers Workshop
Halifax, Nova Scotia, September 23–25, 1991

First Row (left to right): Fred Bustard (Department of National Defence, Vancouver), Lorne Murton (Western Region–Mackenzie River–Beaufort Sea), Darryl Miller (PMO, Atlantic Region, Newfoundland), Randy Sheppard (PMO, Atlantic Region), Dennis Blanchard (PMO, Quebec Region), Rick Shukster (PMO, Ontario Region); **Second Row** (left to right): Keith Clifford (PMO, Ontario Region), Ron Fordyce (PMO, Ontario Region and Superintendent, Marine Data Unit), Stew Arkwell (Department National Defence, Halifax), Bob McCarter (PMO, Vancouver), Lloyd Barnaby (AES Headquarters); **missing** Ron MacLaren (PMO, Vancouver and Buoy Specialist) and Mike McNeil (PMO, Atlantic and Buoy Specialist).

The Mackinaw Race

One of the most popular races on the Great Lakes is the annual Mackinaw Race. Over 300 sailboats in various classes make the 333–mile trek each summer, from Chicago to Mackinac Island. The photograph (left) was take by Chicago PMO Bob Collins at the beginning of the race as the vessels approach the starting line in Chicago. Not only is the race exciting, but it is one of great beauty as well.

Annual Outstanding Observing Awards, 1990

2/O Reinhard Peters (above) in a NOAA cap accepts the Outstanding award from Norfolk PMO Ray Brown on behalf of the ***Sea Merchant****. The* ***Caribe I*** *was honored out of the Miami region and, below, Captain Ossi Suihko (left) and 2/O Ronny Boig represent the vessel.*

Above, Pete Connors (middle) presents the plaque to Captain Charles Molyneaux (left) and QCM Joe Schebal from the NOAA Ship ***Malcolm Baldrige****. Below, representing the U.S. Coast Guard Cutter* ***Steadfast*** *are (left to right) RD2 R.A. Meyer, LCDR E.V. Mark and QCM D.P. Keith; Pete Connors is the PMO from Miami.*

Out West, the M/V ***Ferncroft*** *was a winner (above) and accepting the award in Bob Webster's region are C/O Joachim Zeidler (left) and 2/O Victorio S. Javier. Below, from the bridge of the* ***Edgar B. Speer****, are (left to right) Captain Francis Altman, 3d Mate John Downey and 1st Mate Thomas Lanthier; 2d Mate Paul Andersen was unavailable. Bob Collins presented the award to this Great Lakes vessel, which is also mentioned on page 19 of this issue.*

Another Webster award goes to Captain Eric Buck of the R/V ***New Horizon*** *for their outstanding year in the VOS program. From the NOAA Ship* ***Discoverer*** *(below), CQM Bernard J. Greene accepts the plaque on behalf of the entire crew. The* ***Discoverer*** *is out of Seattle and has several awards to its credit.*

Above, Captain A. Jefferson represents the crew of the M/V ***Sea-Land Trader*** *in accepting the VOS outstanding contribution plaque for 1990. Another winner in the Oakland–San Francisco region was the M/V* ***President Washington*** *and the award is accepted by Captain Gary Moen below.*

Above we have two Captains accepting as the crew was changing over on the M/V ***President Lincoln.*** *To the left is Captain Jimmy Dykes and to the right is Captain Norman Sollid. Below, Captain Richard Crane of the Matsonia is presented the award by Bob Novak, PMO for San Francisco (right).*

Out of Seattle, the ***Bay Bridge*** *was sighted for its outstanding contribution to the VOS program in 1990 (above). From left to right are 3/O Bonifacio Manalo, Captain Kzisuke Nagato, and C/O Masaru Sazki. Below, Captain R.S. Labarre accepts the plaque on behalf of the S.S.* ***Greatland****, also from the Seattle area.*

Above right, the ***Totem Ocean Trailer Express*** *is represented by Bob Magee (Vice President) and the Master of the vessel, Captain O.M. Wardel (right). Below, a special recognition is paid to Ralph Walker, Supervisory Weather Service Radar Specialist at the Tampa Bay area Weather Service Forecast Office. Over the years, Ralph has been visiting ships in the Tampa Bay area, where there is no PMO. The VOS program is fortunate to have volunteers like Ralph who take the time to help the program.*

More Great Lakes Organizations

GLERL

The Great Lakes Environmental Research Laboratory (GLERL), located in Ann Arbor, MI, is one of NOAA's 11 environmental laboratories in the Office of Oceanic and Atmospheric Research.

Throughout its history, GLERL has traditionally focused on investigations to improve our understanding of, and ability to predict, the biological, chemical and physical processes occurring in coastal and estuarine waters, with special emphasis on the Great Lakes. GLERL has recently undergone a major reorganization to develop programs directed toward critical issues, including water quality, water quantity, physical hazards and exotic species intrusions.

The Great Lakes are the largest fresh water reservoir in the world (65 trillion gallons) and contain a full 20% of the world's surface fresh water, and almost 90% of the United States surface fresh water. In total, about 45 billion gallons of lake water are withdrawn every day for municipal, industrial and agricultural use and for power generation.

In return, about 20 billion gallons of waste (municipal and industrial) are discharged every day into the Great Lakes and their connecting channels. However, their vast volume of fresh water does not make them an infinite repository for wastes. The nature of mixing in the lakes and the residence time of water in each of them (190 years in Lake Superior to 3 years in Lake Erie) mean that wastes put into them now will be retained on a time scale of tens to hundreds of years– plenty of time to degrade the environment and upset the fragile ecosystem.

Past problems, such as bird mortality from DDT, sea lamprey decimation of lake trout, the build-up of high levels of PCBs in the ecosystem and the *Lake Erie is dead era*, had to be addressed after-the-fact. While many problems have been alleviated as a result of research, lasting effects are still apparent and will continue for several lifetimes.

Recently, three new invading organisms from Europe have been discovered in the Great Lakes (see page 35). The zebra mussel, a large zooplankter and the river ruffe all have the potential to seriously disrupt the ecosystem. The zebra mussel is expected to become a national problem over the next decade. In 1991, GLERL initiated a major project on the zebra mussel in coordination with NOAA's Sea Grant, which will focus initially on these recent invaders of the Great Lakes.

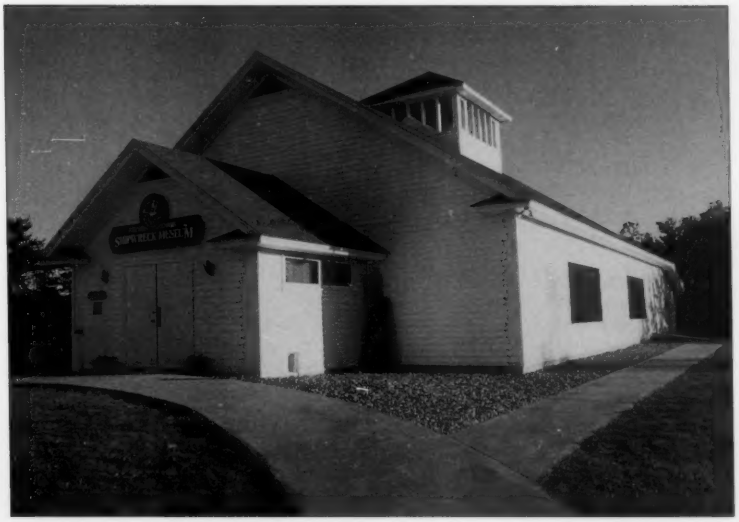
Great Lakes Shipwreck Historical Society

The Whitefish Point Light is the oldest operating light on Lake Superior. It began in 1849, and was last manned in 1971. Since then, it has been automated and controlled from Sault Ste. Marie. The buildings there have become a fitting tribute to the mariners that have plied the treacherous waters of Lake Superior– often known as the Graveyard of the Great Lakes. They are now part of a museum established in 1985 by the Great Lakes Shipwreck Historical Society. From the loss of the British

*This is a view of the lightkeepers quarters (left) at the Whitefish Point Light Station and the Museum (below). Nearby Tahquamenon Falls draws nearly half a million people annually, and many make the journey to Whitefish Point where they can stroll the windswept beaches and easily imagine the danger that nature can force upon the mariner along the beautiful but rugged coast. The **Edmund Fitzgerald** is the most popular topic of conversation at the museum, thanks to the notoriety given the incident by Canadian folk singer Gordon Lightfoot in his popular ballad, "Wreck of the Edmund Fitzgerald."*

schooner ***Invincible*** in 1816 to the wreck of the ***Edmund Fitzgerald*** in 1975, the Great Lakes Shipwreck Historical Society is dedicated to preserving the lore and artifacts of the Lakes. The two-story former caretaker's residence is leased to the Society for 25 years. . The first floor displays artifacts and houses a small theater, which features films about the wrecks and the historical group's work. There are artifacts from the steamer ***Comet***, lost on August 26, 1875 and the sailing steamer ***Samuel Mather***, which sank on November 22, 1891.

Tom Farnquist, Director of the Society was also involved with expedition to explore the wreck of



the ***Edmund Fitzgerald***, which was filmed for the National Geographic Society's *Explorer* television series. Michigan Sea Grant was a sponsor of this expedition, as mentioned in our lead article.

The Great Lakes Shipwreck Historical Museum is located at Whitefish Point on Michigan's Upper Peninsula. This remote location was the site of one of the most strategic lighthouses on Lake Superior and is near a location where many ships sank. Fifty major wrecks have taken place along the *shipwreck coast* from Grand Marias, MI to the St. Mary's River.

Codes and INMARSAT

Martin S. Baron
National Weather Service

Coding Section 0 of the Ships Synoptic Code

When coding weather observations, it is of the utmost importance to follow all procedures and code specifications very carefully. This is not only to make sure the report arrives at the National Weather Service and can be distributed on the Global Telecommunication system, but also to ensure it can be understood by the meteorologists and credited to the proper ship. Of particular importance is section 0, which consists of the first five code groups. This section identifies your report as a ship report, and contains your vessel's position. If section 0 is not coded properly, the report is of little use, and the computer at the National Meteorological Center in Suitland, Maryland, may discard it (this happens to some reports every day). The code form and definitions for section 0 are as follows:

Synoptic Code Section 0
BBXX D.....D YYGGiw 99LaLaLa QcLoLoLoLo

	Definitions
BBXX	Ship's weather report identifier
D.....D	Ship's radio call sign.
YY	Day of the month (UTC)
GG	Hour of the observation (UTC)
iw	Wind measurement indicator
99	Position groups indicator
LaLaLa	Latitude
Qc	Quadrant of the Globe
LoLoLoLo	Longitude

The BBXX indicator is always the first group of the weather message, and is the international identifier for a ships weather report. D.....D, your radio call letters, can be up to seven characters long. YY and GG, the day and observation hour in Universal Time Coordinated (UTC), are coded with two digits each – YY as 01, 02, 10 etc; GG as 06, 09, 12 etc. For GG, use the time the barometer is read rounded off to the nearest whole hour UTC, e.g. both 1152 and 1208 would be coded as 12. The wind measurement indicator, iw is coded as 3 for estimated wind speed, and as 4 for anemometer-measured wind speed.

99, the ship's position groups indicator (position is identified by latitude, quadrant, and longitude), always preceeds the latitude, LaLaLa. Latitude is indicated in whole degrees and tenths of a degree, with the decimal point left out i.e. 50.8 degrees is entered as 508; 25.0 degrees is entered as 250. For values less than 10 degrees, the first La is coded as zero i.e. 6.2 degrees is entered as 062. To convert minutes to tenths of a degree, divide the minutes by six and disregard the remainder i.e. 35 minutes is 5 tenths; 57 minutes is 9 tenths. Qc, the quadrant, is coded as either 1, 3, 5, or 7, according to your latitude and longitude. If your latitude/longitude are north and east, respectively, code Qc as 1; if south and east, code Qc as 3; if south and west, code Qc as 5; if north and west, code Qc as 7. LoLoLoLo (longitude), like latitude, is reported in whole degrees and tenths of a degree. As is done for latitude, convert minutes to tenths by dividing minutes by six and dropping the remainder. For values less than 10 degrees of longitude, the first two Lo's are coded as zero. For values less than 100 degrees of longitude, the first Lo is coded as zero. Examples: 2 degrees 27 minutes longitude is entered as 0024; 25 degrees 47 minutes is entered as 0257; 163 degrees 56 minutes is entered as 1639.

See the July 1991 edition of NWS Observing Handbook No. 1, Chapter 3, pages 3-1 through 3-7, for a complete discussion of synoptic code section 0.

INMARSAT Weather Reports

The NWS has traditionally paid for up to 2 minutes of satellite time to allow for transmission of ship weather reports. Normal transmission time for these reports is in the order of 30 seconds. Current budgeting requires that we limit our acceptance time to 1 minute. This should be transparent to the great majority of users and is not expected to significantly reduce the number of reports received. Those few ships exceeding the one minute limit are requested to make every effort to meet this new requirement. Each marine weather message is of the utmost importance.

Newark PMO transferred to New Orleans

John Warrelmann, PMO in Newark, New Jersey, for the past 2 years, has accepted a voluntary transfer, and is now PMO in New Orleans, Louisiana. A new PMO for Newark will be selected shortly, to be announced in the next issue of the MWL.

A vacancy announcement has been issued for the Miami, Florida, PMO position. Pete Connors, currently PMO in Miami, expects to retire in January, 1992.

New NWS Observing Handbook distributed to all VOS vessels

During the first week of September 1991, copies of the new National Weather Service (NWS) Observing Handbook No. 1, Marine Surface Weather Observations, were mailed to all vessels in the NWS Voluntary Observing Ship (VOS) Program. Port Meteorological Officers have additional copies to pass out. We've received many complements regarding the new text and format. Chapters 1 (Program Description), 2 (General Observing Practises), 4 (Transmitting the Observation to the NWS), Appendix A (Glossary) and Appendix B (Synoptic Code Quick reference) are all brand new. The glossary was prepared to include all terminology and nomenclature you are likely to encounter as observers. The quick reference in the back provides text page numbers for all synoptic code symbols, and replaces the tab separators of the previous edition. Chapter 3 (Ships Synoptic code with Observing Instructions) is an updated and revised version of the old chapter 2. It contains a new set of color sea state photographs covering one half page each, for use with your beaufort scale wind speed estimates. It also contains a description of the new high speed wind group, 00fff. We've used lithocoated paper stock, a much higher quality stock, which should hold up better under marine conditions. We would like to hear from you about the book – comments, new ideas, and suggestions are always welcome.

New Recruits July - September, 1991

PMO's recruited 32 vessels into the VOS program during July, August, and September of 1991. Thank you for joining the program.

Please remember that the worldwide weather reporting schedule for VOS is four times daily, at 0000 0600, 1200, and 1800 (UTC). It is also standard practice worldwide to report weather once every three hours when within 300 miles of named tropical storms or hurricanes. The United States and Canada have a special three hourly coastal waters reporting schedule (from within 200 miles of the United States or Canadian coastlines, including the coasts of the Hawaiian Islands and Alaska). Three hourly reports are also requested from the Great Lakes. Please send Special or Storm reports at any time, when appropriate. See pages 1-3 and 1-4 of NWS Observing Handbook No. 1 for more information on the reporting schedules.

New recruits should also be aware of the NWS observing supplies available to them. These include:

Books and Publications

1. NWS Observing Handbook No. 1, Marine Surface Weather Observations
2. Selected Worldwide Marine Weather Broadcasts
3. Radio Stations Accepting Ships' Weather and Oceanographic Reports
4. Mariners Weather Log
5. Notice To Mariners (by mail from the Defense Mapping Agency)
6. Worldwide Marine Radiofacsmile Broadcast Schedule

Forms and Observing Aids

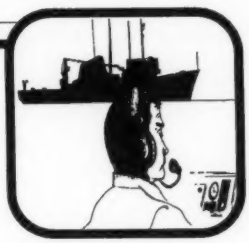
1. Ships Code Card
2. Ships Weather Observations, NOAA Form B-81
3. Weather Report For Immediate Transmission, NOAA Form B-80
4. Surface Analysis Decode Card
5. True Wind Plotting Board

Charts

1. Cloud Identification Chart
2. Sea state Photographs For Determining Wind Speed
3. Pilot Charts – North Atlantic and North Pacific
4. Radio Weather Charts (Weather Map Bases)
5. Explanation of the Daily Weather Map

NATIONAL WEATHER SERVICE VOLUNTARY OBSERVING SHIP PROGRAM
NEW RECRUITS FROM JULY 1 – SEPTEMBER 30, 1991

NAME OF SHIP	CALL	AGENT NAME	RECRUITING PMO
ALPENA WAV	4647	INLAND LAKES MANAGEMENT INC	CLEVELAND, OH
ARCO JUNEAU	KSBG	ATLANTIC RICHFIELD CO	LOS ANGELES, CA
ARILD MAERSK	9VBT	MAERSK LINES	SAN FRANCISCO, CA
ATLANTIC SENTRY	NJAS	USCG MAP KEYWEST	MIAMI, FL
CAPE DUCATO	WMHF	INTEROCEAN MANAGEMENT INC.	NORFOLK, VA
CHAITEN	ELHO7	SOUTHERN SHIP MANAGEMENT CO.	NEW YORK CITY, NY
CONTINENTAL RELIANCE	PDLB	VINKE & CO.	NORFOLK, VA
CONTINENTAL SPIRIT	PDLC	VINKE & CO.	NORFOLK, VA
CURTIS	WMRM	AMERICAN OVERSEAS MARINE CORP	SAN FRANCISCO, CA
EVER GATHER	BKHA	EVERGREEN MARINE CORP	NEWARK, NJ
HANJIN ROTTERDAM	D9SR	HANJIN SHIPPING COMPANY	LOS ANGELES, CA
HELM STAR	3EPV4	NYK LINE N. AMERICA INC	SEATTLE, WA
HOEGH DUKE	ZHFY4	STRACHAN SHIPPING CO.	NORFOLK, VA
HUAL LISITA	LAXK2	AUTOLINERS INC	JACKSONVILLE, FL
JACKSONVILLE	WNDG	BILL LUKOWSKI STEAMSHIP AGENCY	BALTIMORE, MD
JAPAN ALLIANCE	7KBW	MERIT STEAMSHIP AGENCY	LOS ANGELES, CA
LAUST MAERSK	OXGS2	MAERSK LINE	SEATTLE, WA
MADISON MAERSK	OVJB2	MAERSK INC	SAN FRANCISCO, CA
OAXACA	PGLA	TRANS-AMERICA SS AGENCY	LOS ANGELES, CA
OBOD	YTXO	GULF & EASTERN S/S	HOUSTON, TX
PA AIR NTL GUARD	PAANG	146 WEATHER FLIGHT	HOUSTON, TX
PROSPERITY	ELNT9	TRANS ATLANTIC, INC.	MIAMI, FL
R P CAYMAN	DVOE	GANYMED SCHIFFAHRTSGESELLSCHAFT	LOS ANGELES, CA
RISING STAR	ELKM9	IKE MARITIME CO. LTD	HOUSTON, TX
STAR MASSACHUSETTS	KAAD	TEXACO INC	LOS ANGELES, CA
STELLAR VENUS	DUMF	F.W. MYERS CO INC	SEATTLE, WA
SYOSSET	KALD	MOBIL SHIPPING/TRANSPORTATION CO	SAN FRANCISCO, CA
UCHOA	ELBU9	CARGILL AGRICOLA SA	NEWARK, NJ
USCGC RUSH	NLVS	USCGC RUSH	SAN FRANCISCO, CA
USNS KAWISHIWI	NNQD	COMMANDING OFFICER	HONOLULU, HA
USNS NAVAJO	NOYK		LOS ANGELES, CA
ZUIJIN	HPHI	NYK LINE	LOS ANGELES, CA



Schedule Changes

James Nelson
PMO, Houston

MOSCOW 2, U.S.S.R.

CALL SIGN	FREQUENCIES	TIMES	EMISSION	POWER
RTO	53.6 kHz	CONTINUOUS	F3C	
RVO73	5150 kHz	CONTINUOUS	F3C	
RAN77	6880 kHz		F3C	
RCC76	7670 kHz	CONTINUOUS	F3C	
RKA78	10230 kHz	CONTINUOUS	F3C	
RW277	11525 kHz	0230-1605	F3C	
RKU71	13470 kHz	CONTINUOUS	F3C	

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0013/1213	12HR 400MB PROG	90/576	0600	S
0030/------	500MB ANAL	90/576	1200	S
------/1230	300MB ANAL	90/576	0600	S
0047/0050	RADAR DATA	90/576	00/12	M
0110/------	TEST CHART	90/576		
------/1315	500MB ANAL	120/576	0000	XN
------/1340	TEST CHART	60,120/576		
0235/1435	24HR 200MB PROG	120/576	12/00	R
0249/1449	925MB ANAL	90/576	00/12	S
0305/1505	TROPOPAUSE ANAL	90/576	00/12	A
0330/1530	400MB ANAL	90/576	00/12	A
0355/1555	RADAR DATA	90/576	03/15	M
0420/1620	300MB ANAL	90/576	00/12	A
0445/------	24HR 250MB PROG	120/576	1800	R
------/1645	200MB ANAL	90/576	1200	A
0500/------	24HR 300MB PROG	120/576	1800	R
------/1710	24HR 250MB PROG	120/576	0600	R
0515/------	24HR SIGNIFICANT WEATHER PROG	120/576	1800	R
------/1725	24HR 300MB PROG	120/576	0600	R
0530/------	200MB ANAL	90/576	0000	A
------/1740	24HR SIGNIFICANT WEATHER PROG	120/576	0600	R
0554/------	SIGNIFICANT WEATHER & 12HR UPPER LEVEL PROG	90/576	1200	S
------/1755	NEPHANAL/FORECAST OF CLOUDS	120/576	12/16	E
0610/------	12HR 300MB PROG	90/576	1200	S
------/1810	SIGNIFICANT WEATHER & 12HR UPPER LEVEL PROG	90/576	0000	S
0625/------	NEPHANAL/FORECAST OF CLOUDS	120/576	00/04	E
------/1828	12HR 300MB PROG	90/576	0000	S
0643/1845	SIGNIFICANT WEATHER & 12HR LOW LEVEL PROG	90/576	12/00	D
0659/1903	12HR 400MB PROG	90/576	12/00	S
0715/1920	RADAR DATA	90/576	06/18	M
0740/------	MAX TEMP/12HR PRECIP	120/576		L
0755/1945	MAX WIND ANAL	90/576	00/12	A
------/2010	850MB ANAL	90/576	1200	B
0820/------	100MB ANAL	120/576	0000	A
0838/2035	700MB ANAL	90/576	00/12	B
0905/2105	850MB ANAL	90/576	00/12	S
0922/2122	700MB ANAL	90/576	00/12	S
0939/------	500MB ANAL	90/576	0000	S
------/2139	300MB ANAL	90/576	1200	S
0956/2155	RADAR DATA	90/576	09/21	M
1020/2220	24HR 250MB PROG	120/576	00/12	R
1035/2235	24HR 300MB PROG	120/576	00/12	R
1050/2250	24HR SIGNIFICANT WEATHER PROG	120/576	00/12	R
1105/2304	400MB ANAL	90/576	06/18	S
1120/2320	SIGNIFICANT WEATHER & 12HR UPPER LEVEL PROG	90/576	18/06	S
1138/2338	12HR 300MB PROG	90/576	18/06	S
1155/2355	SIGNIFICANT WEATHER & 12HR LOW LEVEL PROG	90/576	18/06	D

MAP AREAS:
A - 1:15,000,000 73N 104W, 43N 105E, 27N 008W, 18N 042E
B - 1:15,000,000 73N 105W, 34N 010W, 16N 088W, 05N 050W
D - 1:07,500,000 61N 010E, 61N 072E, 43N 022E, 43N 059E
E - 1:15,000,000 47N 040E, 60N 131E, 25N 007E, 32N 073E
L - 1:05,000,000 66N 017E, 66N 057E, 46N 023E, 46N 051E
M - 1:05,000,000 63N 016E, 63N 057E, 43N 023E, 42N 050E
R - 1:30,000,000 39N 066W, 18N 149E, 06N 014E, 02S 088E
S - 1:15,000,000 58N 018W, 58N 108E, 30N 016E, 32N 072E
XN - 1:30,000,000 NORTHERN HEMISPHERE

(INFORMATION DATED 04/1991)

ROME, ITALY

CALL SIGNS	FREQUENCIES	TIMES	EMISSION	POWER
IMB51	4777.5 kHz	CONTINUOUS	F3C	5 KW
IMB55	8146.6 kHz	CONTINUOUS	F3C	5 KW
IMB56	13597.4 kHz	CONTINUOUS	F3C	5 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0055/1255	24HR FL390 WIND/TEMP / FL300 WIND/TEMP PROGS (1)	120/576	12/00	M
0117/1317	24HR FL340 WIND/TEMP PROG (1)	120/576	12/00	M
0129/1329	24HR FL240 WIND/TEMP / FL180 WIND/TEMP PROGS (1)	120/576	12/00	M
0151/1351	24HR FL100 WIND/TEMP / FL50 WIND/TEMP PROGS (1)	120/576	12/00	M
0248/1448	24HR TROPOPAUSE/MAX WIND PROG FL100-450 (1)	120/576	12/00	M
0345/1555	24HR SIGNIFICANT WEATHER PROG (2)	120/576	12/00	B1
0400/------	3HR PRESSURE CHANGE/500MB ANAL	120/576	0000	D/B
------ /0410	SURFACE ANAL - ITALY	120/576	1500	I
0415/------	SURFACE ANAL (SUMMER ONLY)	120/576	0000	B1
0425/------	850MB ANAL/FREEZING LEVEL ANAL	120/576	0000	B
------/1630	24HR LOW LEVEL SIGNIFICANT WEATHER PROG	120/576	0000	I1
0437/------	SURFACE ANAL - ITALY	120/576	0300	I
------ /1645	SURFACE ANAL - EUROPE	120/576	1200	B
0457/------	SURFACE ANAL (6)	120/576	0000	B1
------ 1700	3HR PRESSURE CHANGE/500MB ANAL	120/576	1200	D
0510/1715	700MB ANAL/300MB ANAL	120/576	00/12	B
0522/1730	200MB ANAL/TROPOPAUSE-MAX WIND	120/576	00/12	B
0610/------	12HR SIGNIFICANT WEATHER PROG - ITALY	120/576	1200	I1
------ /1810	FREEZING LEVEL ANAL/850MB ANAL	120/576	1200	B
0655/1855	18HR FL390 WIND/TEMP / FL300 WIND TEMP PROGS (1)	120/576	18/06	M
0717/1917	18HR FL340 WIND/TEMP PROG (1)	120/576	18/06	M
0729/1929	18HR FL240 WIND/TEMP / FL180 WIND/TEMP PROGS (1)	120/576	18/06	M
0751/1951	18HR FL100 WIND/TEMP / FL50 WIND TEMP PROGS (1)	120/576	18/06	M
0813/------	TEST CHART	120/576		
0823/------	24HR 500MB PROG (3)	120/576	0000	A
0848/2048	18HR SIGNIFICANT WEATHER PROG (1)	120/576	18/06	M
0859/------	48HR 500MB PROG	120/576	0000	E
0906/------	72HR 500MB PROG	120/576	0000	E
0913/------	96HR 500MB PROG	120/576	0000	E
0920/------	120HR 500MB PROG	120/576	0000	E
0927/------	144HR 500MB PROG	120/576	0000	E
1000/------	18HR SIGNIFICANT WEATHER PROG (2)	120/576	1800	B1
------/2200	24HR 500MB PROG (3)	120/576	1200	A
1030/------	24HR SURFACE PROG/3HR PRESSURE CHANGE	120/576	0600	B/D
------/2230	18HR MEDITERRANEAN SEA STATE PROG	120/576	1200	S
1045/------	SURFACE ANAL - EUROPE	120/576	0600	B1
1100/2240	18HR LOW LEVEL SIGNIFICANT WEATHER PROG	120/576	00/12	I1
------/2252	SURFACE ANAL - ITALY	120/576	2100	I
------/2312	SURFACE ANAL - EUROPE	120/576	1800	B
------/2322	24HR SURFACE PROG/3HR PRESSURE CHANGE	120/576	1800	B/D
------/2335	18HR SIGNIFICANT WEATHER PROG (2)	120/576	0600	B1
1140/------	18HR MEDITERRANEAN SEA STATE PROG	120/576	0000	S
1146/------	SURFACE ANAL - ITALY	120/576	0900	I

NOTES:
(1) REBROADCAST OF OFFENBACH (EDZW) TRANSMISSIONS.
(2) TRANSMITTED ONLY IF OFFENBACH CHART (0345/0848/1555/2335) IS MISSING.
(3) REBROADCAST OF BRACKNELL (EGRR/EGLL) TRANSMISSIONS.
(4) CHARTS IN PICTORIAL FORM OF WASHINGTON (KWBC) FORECASTS.
(5) CHARTS IN PICTORIAL FORM OF ECMWF READING FORECASTS.
(6) REPLACES 0415/------ SURFACE ANAL AT END OF SUMMER.

MAP AREAS:
A - 1:20,005,000 48N 145W, 32N 068E, 24N 069W, 15N 010E
B - 1:20,000,000 52N 031W, 45N 061E, 24N 010W, 21N 037E
B1 - 1:15,000,000 52N 031W, 45N 051E, 24N 010W, 21N 037E
D - 1:15,000,000 49N 025W, 49N 045E, 28N 010W, 28N 030E
E - 1:40,000,000 54N 090W, 54N 090E, 17N 027W, 17N 027E
I - 1:02,500,000 48N 005E, 48N 019E, 35N 005E, 35N 019E
I1 - 1:04,000,000 50N 005E, 50N 020E, 35N 005E, 35N 020E
M - 1:15,000,000 51N 046W, 58N 060E, 25N 017W, 27N 033E
S - 1:10,000,000 45N 006W, 41N 029E, 29N 001W, 26N 031E

(INFORMATION DATED 01/1991)

OFFENBACH/MAIN-MAINFLINGEN 1, F.R.G.

CALL SIGN	FREQUENCY	TIMES	EMISSION	POWER
DCF54	134.2 kHz	CONTINUOUS	F3C	50 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
------/1200	EXPERIMENTAL TRANSMISSION	120/576		
------/1244	METEOSAT-IR (EUROPE) (1)	120/576	1200	X6
------/1300	METEOSAT-VIS (EUROPE) (1)	120/576	1200	X6
0103/------	METEOSAT-IR (EUROPE) (1)	120/576	0000	X6
0122/1319	PLOTTED SURFACE DATA	120/576	00/12	A05
------/1340	SURFACE PROG FOR PRESS AGENCIES	120/576	1200	X5
0144/------	METEOSAT-IR (FULL DISK)	120/576	0000	X4
0200/1350	EXPERIMENTAL BROADCAST (2)	120/576		
------/1408	NORTHERN HEMISPHERE SURFACE ANAL/W PLOTTED DATA	120/576	0000	Q30
0230/1430	TEMP/RAWIN LIST 1 (3) (4) 06181, 06260, 06610, 09184, 09393, 09548, 10035, 10338, 10410, 10739, 10868, 11035	120/288	00/12	
0241/1441	TEMP/RAWIN LIST 2 (3) (4) 03005, 03170, 03496, 03774, 03808, 03920, 06447, 07110, 07145, 07461, 07510, 07645	120/288	00/12	
0252/1452	PLOTTED UPPER AIR DATA (850MB-200MB)	120/576	00/12	B15
------/1512	TEMP/RAWIN LIST 4 (3) (4) 11520, 12843, 13275, 16044, 16080, 16242	120/288	1200	
0315/------	METEOSAT-EIR (EUROPE) (1)	120/576	21-02	X14
------/1518	950MB/850MB/700MB TRAJECTORIES	120/576	0000	X2
------/1539	METEOSAT-EIR (EUROPE) (1)	120/576	09-15	X14
0340/------	RELATIVE TOPOGRAPHY, 500-1000MB WITH PLOTTED DATA/ 12HR STABILITY & VERTICAL MOTION PROGS(7)	120/576	0000	K15 X1
0349/------	SURFACE ANAL & 24HR PROG/850MB TEMP/700MB RH/ 500MB ANAL & 24HR PROG	120/576	0000	D80
0400/1557	SURFACE ANAL WITH PLOTTED DATA	120/576	00/12	D15
0420/1617	PLOTTED SURFACE DATA	120/576	03/15	A05
------/1637	RELATIVE TOPOGRAPHY/500-1000MB WITH PLOTTED DATA/ 12HR STABILITY AND VERTICAL MOTION	120/576	1200	K15 X1
0440/1646	SURFACE ANAL & 12HR, 24HR, 36HR PROGS/ 500MB VORTICITY ADVECTION ANAL/ 24HR 1000/500MB THICKNESS ADVECTION/ 700MB DIVERGENCE/850MB FRONTOGENETIC PARAMETER TEMP/RAWIN LIST 4 (3)(4) 11520, 12843, 13275, 16044, 16080, 16242	120/288	00/12	D80
0500/------	500MB ANAL WITH PLOTTED DATA	120/288	0000	
0506/1657	24HR SURFACE/24HR 500-1000MB PROG	120/576	00/12	D15
0526/1717	300MB ANAL WITH PLOTTED DATA	120/576	00/12	D30
0537/1728	850MB/700MB ANALS WITH PLOTTED DATA	120/576	00/12	D15
0557/1748	850MB ANAL & 24HR/48HR/72HR PROGS	120/576	00/12	C15
0617/------	24HR 700MB/300MB/200MB/100MB PROGS	120/288	0000	D30
------/1808	500MB ANAL & 24/48/72HR PROGS	120/288	1200	D30
0628/1819	24HR 700MB/300MB/200MB/100MB PROGS	120/288	00/12	D30
0639/------	850MB ANAL & 24/48/72HR PROGS	120/288	1200	D30
------/1830	METEOSAT-IR (EUROPE) (1)	120/576	06/18	X6
0652/1843	200MB ANAL WITH PLOTTED DATA	120/576	00/12	D15
0710/1901	PLOTTED SURFACE DATA	120/576	06/18	A05
0730/1921	12HR/36HR/60HR/84HR SURFACE PRESSURE/ 500MB HT & TEMP/850MB TEMP/700MB RH PROGS	120/576	1200	D80
0750/------	24HR/48HR/72HR/96HR SURFACE PRESSURE/ 500MB HT & TEMP/850MB TEMP/700MB RH PROGS	120/576	1200	D80
------/1941	24HR AMOUNT OF PRECIP WITH 24HR/48HR/72HR PROGS	120/576	0000	L10
0810/------	5-DAY MEAN WATER TEMPS (TUE & FRI)	120/576		P15
------/2001	PLOTTED UPPER AIR DATA (850MB-200MB)	120/576	06/18	B15
0830/2021	METEOSAT-VIS (EUROPE) (1) OR	120/576	0730	X12
0852/------	METEOSAT-EIR (EUROPE) (5)	120/576	03-08	X14
0909/------	AGROMETEOROLOGICAL INFORMATION	120/576		X3
0922/------	48HR/72HR SURFACE PROGS	120/576	0000	D30
0933/------	24HR SURFACE PROG/12HR AMOUNT OF PRECIPITATION	120/576	0600	D30/K15
------/2143	METEOSAT-EIR (EUROPE) (1)	120/576	15-21	X14
0944/------	EXTREME TEMPS/ EXTREME TEMPS & AMOUNT OF PRECIP PAST 24HRS	120/576		R15 E05
1000/2201	SURFACE ANAL WITH PLOTTED DATA	120/576	06/18	D15
1020/2221	PLOTTED SURFACE DATA	120/576	09/21	A05
1040/------	TEST CHART OR THERMOPLUVIOGRAM (8)	120/576		
1050/------	NORTHERN HEMISPHERE 300MB ANAL WITH PLOTTED DATA	120/576	0000	Q30
------/2241	24HR SURFACE PROG/12HR AMOUNT OF PRECIP	120/576	06/18	D30/K15
1112/------	48HR 500MB PROG	120/576	0000	XX11
1125/------	72HR 500MB PROG	120/576	0000	XX11
1138/------	AGROMETEOROLOGICAL INFORMATION/ OR SNOW DEPTH (TUE & FRI, WINTER ONLY)	120/576	0600	X3 J15
1151/------	36HR SURFACE PRES, CLOUD COVERAGE, CONVECTION PROGS/36HR STABILITY FIELD & VERTICAL MOTION PROGS	120/576	0000	X1

NOTES:
1. OTHER IMAGERY WILL BE SUBSTITUTED IN CASE OF NON-RECEIPT.
2. CONTENT WILL BE PUBLISHED IN EACH CASE SEPARATELY.
3. PSEUDO-ADIABATIC DIAGRAM UP TO 225MB.
4. TEMP/RAWIN LIST 3 AVAILABLE IN PROGRAM 2 (DCF 37) 117.4 KHZ.
5. FROM 1 OCT-31 MAR OF EACH YEAR OR IN CASE OF NON-AVAILABILITY OF METEOSAT-VIS IMAGE, EUROPE 0730 GMT.
6. SURFACE PROGS WITH FRONTS WITH CLOUD COVERAGE OF MORE THAN 6 OKTAS ARE MARKED OFF BY UNDULATING LINES.
7. THE STABILITY FIELD KO (ISOLINES IN DEGREES CELCIUS) REPRESENTS A SMOOTHED VERTICAL GRADIENT OF THE POTENTIAL EQUIVALENT.
8. 10TH OF EACH MONTH, OR ON THE 12TH IF THE 10TH IS A SUNDAY OR MONDAY

MAP AREAS:
A05 - 1:05,000,000 65N 019W, 63N 030E, 42N 009W, 41N 015E
B15 - 1:15,000,000 59N 025W, 63N 027E, 33N 007W, 35N 018E
C15 - 1:15,000,000 69N 062W, 71N 103E, 28N 009W, 26N 026E
D15 - 1:15,000,000 SAME AS D30 CHART
D30 - 1:30,000,000 40N 061W, 63N 102E, 17N 029W 27N 033E
D60 - 1:60,000,000 SAME AS D30 CHART
E05 - 1:05,000,000 56N 005E, 55N 016E, 47N 004E, 46N 013E
J15 - 1:15,000,000 78N 065W, 63N 102E, 31N 000 27N 033E
K15 - 1:15,000,000 59N 034W, 01N 045E, 35N 011W, 39N 029E
L10 - 1:10,000,000 59N 006W, 60N 020E, 40N 000 41N 016E
P15 - 1:15,000,000 40N 061W, 71N 103E, 18N 029W, 29N 026E
Q30 - 1:30,000,000 12N 106W, 07N 125E, 03S 039W, 06S 057E
R15 - 1:15,000,000 63N 012W, 43N 049E, 36N 009W, 27N 028E
X1 - 1:30,000,000 70N 078W, 65N 096E, 27NT007W, 26N 031E
X2 - 1:30,000,000 59N 047W, 68N 048E, 32N 015W, 35N 024E
X3 - 1:02,500,000 GERMANY
X4 - FULL EARTH DISC
X5 - 1:24,600,000 57N 028W, 53N 055E, 30N 009W, 28N 033E
X6 - 1:15,000,000 52N 061W, 67N 068E, 22N 019W, 27N 027E
X12 - 1:05,000,000 56N 017W, 59N 022E, 40N 006W, 42N 017E
X14 - 1:15,000,000 57N 031W, 63N 033E, 36N 012W, 38N 022E
XX11- 1:40,000,000 09N 160E, 09N 140E, 01N 126W, 01N 031W

(INFORMATION DATED 09/1991)

NORFOLK, VIRGINIA, U.S.A.

CALL SIGN	FREQUENCIES	TIMES	EMISSION	POWER
NAM	3357 kHz	CONTINUOUS	F3C	
	8080 kHz	CONTINUOUS	F3C	
	10865 kHz	CONTINUOUS	F3C	
	15959 kHz	0900-2100	F3C	
	20015 kHz	1200-2100	F3C	

(INFORMATION DATED 10/1991)

MELBOURNE, AUSTRALIA

CALL SIGNS	FREQUENCIES	TIMES	EMISSION	POWER
AXM 31	2628 kHz	(4)	F3C	5 KW
AXM 32	5100 kHz	CONTINUOUS	F3C	5 KW
AXM 34	11030 kHz	CONTINUOUS	F3C	5 KW
AXM 35	13920 kHz	CONTINUOUS	F3C	5 KW
AXM 37	20469 kHz	CONTINUOUS (5)	F3C	5 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0000/1200	36HR SURFACE PROG	120/576	00/12	AUST
0030/------	AMENDED REGIONAL SIGNIFICANT WEATHER PROG	120/576	0600	RSW
------/1230	500MB ANAL	120/576	0000	SH
0045/------	24HR SURFACE PROG	120/576	0000	AUST
------/1300	36HR SURFACE PROG	120/576	1200	IO
0115/------	FACSIMILE SCHEDULE	120/576		
0130/------	IPS RECOMMENDED FREQUENCIES FOR AXM RECEPTION	120/576		
------/1345	ANTARCTIC SUPPORT CHARTS	120/576		
0200/------	GMS NEPHANALYSIS	120/576	0000	
0215/1430	MEAN SEA LEVEL ANAL	120/576	00/12	AUST
0300/1500	500MB ANAL	120/576	00/12	AUST
0315/------	250MB ANAL	120/5761	0000	AUST
------/1515	24HR MEAN SEA LEVEL PROG	120/576	1200	AUST
0330/1530	18HR SIGNIFICANT WEATHER PROG	120/576	18/06	D
0345/1545	18HR REGIONAL SIGNIFICANT WEATHER PROG	120/576	18/06	RSW
0400/1600	24HR 500MB PROG	120/576	00/12	AUST
0415/1615	24HR MEAN SEA LEVEL PROG	120/576	00/12	AUST
------/1715	250MB ANAL	120/576	1200	AUST
0530/1730	24HR 250MB PROG	120/576	00/12	AUST
0545/------	MAX WIND/TROPOPAUSE ANAL	120/576	0000	AUST
0805/1745	GRADIENT LEVEL WIND ANAL	120/576	00/12	E
0615/------	ANTARCTIC SUPPORT CHARTS	120/576		
0645/1830	12HR AMENDED SIGNIFICANT WEATHER PROG	120/576	12/00	RSW
0715/1915	INDIAN OCEAN MEAN SEA LEVEL ANAL	120/576	00/12	IO
0730/1930	24HR WIND WAVE HT (M) PROG	120/576	0000	AUST
0745/1945	24HR SWELL WAVE HT (M) PROG	120/576	0000	AUST
0800/2000	SOUTH PACIFIC OCEAN MEAN SEA LEVEL ANAL	120/576	00/12	SWP
0815/2015	MEAN SEA LEVEL ANAL	120/576	06/18	AUST
0830/2030	24HR ASIAN 250MB HT/WIND/TEMP PROG	120/576	00/12	ASIAN
0845/2045	24HR INDIAN 250MB HT/WIND/TEMP PROG	120/576	00/12	INDIAN
0915/------	18HR REGIONAL SIGNIFICANT WEATHER PROG	120/576	00/12	RSW
------/2115	30HR INDIAN 250MB HT/WIND/TEMP PROG	120/576	1800	INDIAN
0930/2130	18HR SIGNIFICANT WEATHER PROG	120/576	12/00	D
0945/------	SOUTH PACIFIC OCEAN 36HR 250MB PROG	120/576	1200	SWP
------/2145	18HR REGIONAL SIGNIFICANT WEATHER PROG	120/576	1200	RSW
1000/2200	30HR ASIAN 250MB HT/WIND/TEMP PROG	120/576	06/18	ASIAN
1015/------	30HR INDIAN 250MB HT/WIND/TEMP PROG	120/576	0600	INDIAN
------/2215	SOUTHERN HEMISPHERE MEAN SEA LEVEL ANAL	120/576	1200	SH
1030/------	48HR SOUTHERN HEMISPHERE 500MB PROG	120/576	0000	SH
------/2230	36HR SOUTH PACIFIC OCEAN 250MB PROG	120/576	0000	SWP
1045/------	48HR SOUTHERN HEMISPHERE MEAN SEA LEVEL PROG	120/576	0000	SH
------/2245	36HR SOUTHERN HEMISPHERE 500MB PROG	120/576	1200	SH
1100/------	SOUTHERN HEMISPHERE MEAN SEA LEVEL ANAL	120/576	0000	SH
------/2300	48HR SOUTHERN HEMISPHERE MEAN SEA LEVEL PROG	120/576	1200	SH
1115/------	WEEKLY MEAN SST ANAL (TUE)	120/576	------	E
	SST ANAL & 250M TEMP ANAL OF SE AUSTRALIA (THU)	120/576	------	SEAUST
	ICE BOUNDRY (SAT - DURING SUMMER ONLY)	120/576	------	ICE
1135/------	12HR AMENDED SIGNIFICANT WEATHER PROG	120/576	1800	RSW
------/2330	SOUTHERN HEMISPHERE 500MB ANAL	120/576	1200	SH
1145/------	36HR SOUTHERN HEMISPHERE COMBINED WAVE HT PROG	120/576	1200	SH
------/2345	48HR INDIAN OCEAN MEAN SEA LEVEL PROG	120/576	1200	IO

NOTES:
1. RECEPTION AREA IS SOUTHWARDS OF 10N, BETWEEN 70E & 150W
2. AS AVAILABLE, SUMMER ONLY
3. TRANSMITTED FROM CANBERRA VIA RAAF TRANSMITTERS.
4. MAY-JULY 1100-2100, AUG-OCT 1700-2000
5. TRANSMISSION SUSPENDED FOR THE MONTHS AND TIMES IN NOTE #4.

MAP AREAS:
AUST - 10S 090E, 10S 170E, 50S 080E, 50S180
RSW - 0 - 50S, 100E - 180
ASIAN - 1:35,000,000 45N - 50S, 100E - 180
INDIAN - 1:35,000,000 45N - 50S, 030E - 110E
IO - 1:40,000,000 10S- 90S,000 - 090E - 180
SWP - 1:40,000,000 20S- 90S, 150E - 180 - 90W
SH - 1:60,000,000 10S- 90S, ALL LONGITUDES
SEAUST- 31S- 40S, 148E - 156E
ICE - 50S- 90S, 005E - 175E

(INFORMATION DATED 03/1991)

DARWIN, AUSTRALIA

CALL SIGN	FREQUENCIES	TIMES	EMISSION	POWER
AXI 32	5755 kHz	0800-2100	F3C	10 KW
AXI 33	7535 kHz	0800-2100	F3C	10 KW
AXI 34	10555 kHz	0000-2359	F3C	10 KW
AXI 35	15615 kHz	2100-0600	F3C	10 KW
AXI 37	18060 kHz	2100-0600	F3C	10 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0000/------	RECOMMENDED FREQUENCIES FOR AXI RECEPTION	120/576		
0030/------	FAX SCHEDULE	120/576		H
0200/1400	CURRENT WARNINGS SUMMARY IN PLAIN LANGUAGE	120/576		H
0215/1430	SURFACE ANAL	120/576	00/12	AUST
0330/1530	18HR SIGNIFICANT WEATHER PROG	120/576	18/06	D
0415/------	24HR SURFACE PROG	120/576	00/---	AUST
0805/1745	GRADIENT LEVEL WIND ANAL	120/576	00/12	E
0700/------	MEAN SEA LEVEL PRESSURE ANAL	120/576	0000	A+B
0800/1955	500MB STREAMLINE ANAL	120/576	00/12	C
0820/------	CURRENT WARNINGS SUMMARY IN PLAIN LANGUAGE	120/576		H
0830/2030	ASIAN 24HR 250MB HT/WIND/TEMP PROG	120/576	00/12	ASIA
------/2045	CURRENT WARNINGS SUMMARY IN PLAIN LANGUAGE	120/576		H
0905/2100	250MB STREAMLINE ANAL	120/576	00/12	C
0930/2130	18HR SIGNIFICANT WEATHER PROG	120/576	00/12	ASIA
1000/2200	ASIAN 36HR 250MB HT/WIND/TEMP PROG	120/576	06/18	ASIA
1045/2220	700MB STREAMLINE ANAL	120/576	00/12	C
1115/------	SEA SURFACE TEMP ANAL (TUE ONLY)	120/576		E

NOTES: 1. CURRENT WARNING SUMMARY IS IN PLAIN LANGUAGE AND COVERS FROM 25N-25S, 75E-180.
2. NORMAL RECEPTION AREA IS 25N-25S, 75E-180.

MAP AREAS:
A - 30N - 35S, 130E - 180
B - 30N - 35S, 075E - 130E
C - 35N - 35S, 075E - 180
D - 43S 110E, 36S 155E, 38N 142E, 29N 096E
E - 22N - 23S, 100E - 170E
H - 25N - 25S, 080E - 180
AUST - 10S 090E, 50S 080E, 10S 170E, 55S 180
ASIA - 45N - 50S, 100E - 180

(INFORMATION DATED 03/1991)

GUAM 2, M.I.

CALL SIGN	FREQUENCIES		TIMES		EMISSION	POWER
NPN	5260	kHz	0000-2359*	USB	F3C	
	7580	kHz	1400-0059$	USB	F3C	
	8612.5	kHz	1000-2200#	ISB	F3C	
	10255	kHz	0000-2359*	USB	F3C	
	12726	kHz	0000-2359#	ISB	F3C	
	12804	kHz	0000-2359$	USB	F3C	
	16913	kHz	2200-1000#	ISB	F3C	
	19860	kHz	0000-2359*	USB	F3C	
	20300	kHz	0100-1359$	USB	F3C	
	23010	kHz	0000-2359*	ISB	F3C	

* GUAM FREQUENCIES $ DIEGO GARCIA FREQUENCIES # H.E. HOLT FREQUENCIES

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0005/1205	36HR 500MB PROG (MIDEAST)	120/576	00/12	4
0020/1220	36HR SURFACE PROG BLEND	120/576	00/12	1
0040/1240	36HR SIGNIFICANT WAVE HT PROG	120/576	00/12	1
0100/1300	36HR PROG BLEND	120/576	00/12	1
0120/------	OPEN (MON/THU)			
	SST ANAL (TUE/FRI)	120/576		6
	MSLD ANAL (WED/SAT)	120/576		
	CZ PROB (SUN)	120/576		1
------/1320	INDIAN OCEAN BROADCAST SCHEDULE PART 1 OF 2	120/576		
0135/------	OPEN PERIOD			
------/1335	INDIAN OCEAN BROADCAST SCHEDULE PART 2 OF 2	120/576		
0150/1350	36HR SURFACE PROG (MIDEAST)	120/576	00/12	4
0205/1405	36HR 850/700/300MB PROGS (INDIAN OCEAN)	120/576	00/12	4
0220/1420	36HR 500MB PROG (INDIAN OCEAN)	120/576	00/12	4
0235/1435	36HR SURFACE PROG (INDIAN OCEAN)	120/576	00/12	3
0250/1450	48HR 300MB PROG (MIDEAST)	120/576	12/00	4
0305/1505	48HR 500MB PROG (MIDEAST)	120/576	12/00	4
0320/1520	48HR 700MB PROG (MIDEAST)	120/576	12/00	4
0335/1530	48HR 850MB PROG (MIDEAST)	120/576	12/00	4
0350/1550	48HR SURFACE PROG (MIDEAST)	120/576	12/00	4
0405/1605	48HR 300MB/700MB PROG (INDIAN OCEAN)	120/576	12/00	3
0420/1620	48HR 500MB PROG (INDIAN OCEAN)	120/576	12/00	3
0435/1635	PRELIMINARY SURFACE ANAL (INDIAN OCEAN)	120/576	00/12	3
0450/1650	48HR 850MB PROG (INDIAN OCEAN)	120/576	12/00	3
0505/1705	SIGNIFICANT WAVE HT ANAL	120/576	00/12	2
0525/1725	48HR SURFACE PROG (INDIAN OCEAN)	120/576	12/00	3
0540/1740	SATELLITE IMAGERY (N. INDIAN OCEAN)	120/576	03/15	
0555/1755	SATELLITE IMAGERY (S. INDIAN OCEAN)	120/576	03/15	
0610/1810	SURFACE ANAL	120/576	00/12	2
0630/1830	SURFACE ANAL (MIDEAST)	120/576	00/12	4
0645/1845	72HR 500MB PROG (MIDEAST)	120/576	00/12	3
0700/------	TROPICAL CYCLONE WARNING (INDIAN OCEAN)	120/576	12/---	
------/1900	72HR SURFACE PROG (MIDEAST)	120/576	---/00	4
0715/1915	300MB ANAL (MIDEAST)	120/576	00/12	4
0735/1935	500MB ANAL (MIDEAST)	120/576	00/12	4
0750/1950	850MB ANAL (MIDEAST)	120/576	00/12	4
0805/2005	SURFACE ANAL (MED)	120/576	00/12	9
0820/2020	SATELLITE IMAGERY (GFAX PANEL/DMSP 6.7 NM)	120/576	12/00	
0835/2035	850MB/700MB/300MB ANAL (INDIAN OCEAN)	120/576	00/12	3
0850/2050	500MB ANAL (INDIAN OCEAN)	120/576	00/12	4
0905/2105	48HR SURFACE PROG (MED)	120/576	00/12	9
0920/2120	24HR 300MB PROG (MIDEAST)	120/576	00/12	4
0935/2135	WPAC SATELLITE IMAGERY (A SECTOR)	120/576	09/21	
0950/2150	24HR 500MB PROG (MIDEAST)	120/576	00/12	4
1005/2205	24HR 700MB PROG (MIDEAST)	120/576	00/12	4
1020/2220	PRELIMINARY SURFACE ANAL (INDIAN OCEAN)	120/576	06/18	3
1035/2235	24HR 850MB PROG (MIDEAST)	120/576	00/12	4
1050/2050	24HR SURFACE PROG (MIDEAST)	120/576	00/12	4
1105/2305	24HR 700MB/300MB PROG (INDIAN OCEAN)	120/576	00/12	3
1120/2320	24HR 500MB PROG (INDIAN OCEAN)	120/576	00/12	3
1135/2335	24HR 850MB PROG (INDIAN OCEAN)	120/576	00/12	3
1150/2350	24HR SURFACE PROG (INDIAN OCEAN)	120/576	00/12	3

NOTES: 1. BROADCAST CONTENT MAY CHANGE WITHOUT NOTICE DUE TO OPERATIONAL COMMITMENTS OF THE U.S. NAVY.

2. SAMPLES OF PRODUCTS ANNOTATED WITH DATE, TIME, POSITION, FREQUENCY AND COMMENTS CONCERNING QUALITY AND CONTENT ARE SOLICITED. ADDRESS COMMENTS TO:
NAVAL OCEANOGRAPHY COMMAND CENTER
BOX 12
% F.P.O. SAN FRANCISCO, CA 96630

MAP AREAS: 1 - 60N 035E, 60N 180, 15S 035E, 15S 180
2 - 55N 030E, 55N 180, 45S 030E, 45S 180
3 - 35N 048E, 35N 123E, 35S 048E, 35S 123E
4 - 60N 030E, 60N 105E, EQ 030E, EQ 105E
6 - 35N 030E, 35N 105E, 35S 030E, 35S 105E
9 - 65N 065E, 65N 035W,20N 035W, 20N 065E

(INFORMATION DATED 07/1991)

SOFIA, BULGARIA

CALL SIGN	FREQUENCY	TIMES	EMISSION	POWER
LZJ2	5092.5 kHz	CONTINUOUS	F3C	5 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0415	SURFACE ANAL	120/576	0000	A
0435	SURFACE ANAL (1)	120/576	0300	B
0510	SURFACE ANAL (2)	120/576	0300	B
0550	850MB ANAL	120/576	0000	C
0615	700MB ANAL (1)	120/576	0000	C
0715	700MB ANAL (2)	120/576	0000	C
0735	SURFACE ANAL	120/576	0600	B
0800	TEST CHART	120/576		
0950	SURFACE ANAL	120/576	0600	A
1030	SURFACE ANAL	120/576	0900	B
1330	SURFACE ANAL	120/576	1200	B

NOTES: (1) 26 SEPTEMBER - 5 APRIL
(2) 6 APRIL - 25 SEPTEMBER.

MAP AREAS: A - 1:10,000,000 64N 045W, 60N 063E, 30N 020W, 28N 034E
B - 1:03,000,000 47N 013E, 47N 033E, 36N 014E, 36N 031E
C - 1:15,000,000 64N 045W, 60N 063E, 30N 020W, 28N 034E

(INFORMATION DATED 03/1991)

HAMBURG/PINNEBERG, GERMANY

CALL SIGNS	FREQUENCIES	TIMES	EMISSION	POWER
DDH3	3855 kHz	0600-2300	F3C	0.8 KW
DDK3	7880 kHz	CONTINUOUS	F3C	20 KW
DDK6	13882.5 kHz	CONTINUOUS	F3C	20 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0520	SURFACE ANAL WITH PLOTTED DATA	120/576	0000	D15
0540	500MB ANAL WITH PLOTTED DATA	120/576	0000	D15
0600	24HR SURFACE PROG(1)/24HR 1000-500MB THKNS PROG	120/576	0000	D30
0631	850MB HT-TEMP ANAL & 24HR/48HR/72HR PROGS	120/576	0000	D30
0651	24HR/48HR/72HR SURFACE PRESSURE/850MB TEMP/ 700MB RH/500MB HT-TEMP PROGS	120/576	0000	D60
0711	500MB ANAL WITH PLOTTED DATA	120/576	0000	D15
0731	24HR SURFACE PROG (1)/24HR 1000-500MB THKNS PROG	120/576	0000	D30
0745	NORTH ATLANTIC SURFACE ANAL WITH PLOTTED DATA AND ARROWS SHOWING MOVEMENT OF PRESSURE SYSTEMS, TROPICAL STORMS, SIGNIFICANT WEATHER	120/576	0000	V8
0852	NORTH SEA SEA SURFACE TEMP (2)	120/288		V8
0906	ICE CONDITIONS FOR W. BALTIC SEA AND W. ATLANTIC (2)(3)	120/288		V1
0922	48HR/72HR SURFACE PROGS	120/576	0000	D30
0933	24HR SURFACE PROG(1)/12HR AMOUNT OF PRECIP(4)	120/576	0600	D30/K15
1000	SURFACE ANAL WITH PLOTTED DATA	120/576	0600	D15
1345	BALTIC SEA ICE CONDITIONS (2)(3)	120/576	0900	V1
1408	N. HEMISPHERE SURFACE ANAL WITH PLOTTED DATA	120/576	0000	G30
1430	SCHEDULE/TEST CHART (6)	120/576		
1520	36HR NORTH ATLANTIC WAVE PROG	120/576	1200	V3
1541	BALTIC SEA ICE CONDITIONS (3)(5)	120/576		V6
1557	SURFACE ANAL WITH PLOTTED DATA	120/576	1200	D15
1758	24HR SURFACE PROG (1)/24HR 1000-500MB THKNS PROG	120/576	1200	D30
1809	500MB ANAL WITH PLOTTED DATA	120/576	1200	D15
1830	850MB ANAL WITH 24HR/48HR/72HR PROGS	120/288	1200	D30
1845	NORTH ATLANTIC SURFACE ANAL WITH PLOTTED DATA AND ARROWS SHOWING MOVEMENT OF PRESSURE SYSTEMS, TROPICAL STORMS, SIGNIFICANT WEATHER	120/576	1200	V8
1941	SURFACE/850MB TEMP/700MB RH/500MB HT-TEMP ANALS/ WITH 24HR/48HR/72HR PROGS	120/576	1200	D60
2001	5 DAY MEAN WATER TEMPERATURE (7)	120/576		P15
2021	SEA ICE OBSERVATIONS (8)	120/576		V4
2042	BALTIC SEA ICE CONDITIONS (3)(5)	120/576		W
2126	WEST ATLANTIC ICE CONDITIONS (2)(3)	120/288		N
2140	36HR NORTH ATLANTIC WAVE PROG	120/576	1200	V3
2201	SURFACE ANAL WITH PLOTTED DATA	120/576	1800	D15
2241	24HR SURFACE PROG(1)/12HR AMOUNT OF PRECIP(4)	120/576	1800	D30/K15

NOTES: 1. SURFACE PRESSURE PROGS WITH FRONTS AND AREAS OF MODEL SIMULATED MID-TROPOSPHERIC CLOUD COVERAGE OF MORE THAN 6 OKTAS WHICH ARE MARKED OFF BY THICK UNDULATING LINES.
2. PRODUCED BY: "BUNDESAMB FUR SEESCHIFFART UND HYDROGRAFIE".
3. IRREGULARLY, ONLY IF REQUIRED BECAUSE OF ICE CONDITIONS.
4. AMOUNT OF PRECIPITATION (mm) 1800 TO 0600 UTC (0933 TRANSMISSION) AND 0600 TO 1800 UTC (2241 TRANSMISSION).
5. REBROADCAST OF NORRKOPING (ESWI) TRANSMISSIONS.
6. ON MONDAYS ONLY.
7. REPRODUCED ON TUESDAYS AND FRIDAYS ONLY. THE OTHER DAYS WILL BE REPETITION OF THE PREVIOUS CHART.
8. REBROADCAST OF BRACKNELL (EGRR) TRANSMISSIONS

MAP AREAS: D15 - 1:15,000,000 SAME AS D30 CHART
D30 - 1:30,000,000 40N 081W, 63N 092E, 17N 029W, 27N 033E
D60 - 1:60,000,000 SAME AS D30 CHART
K15 - 1:15,000,000 59N 034W, 61N 049E, 35N 011W, 35N 028E
P15 - 1:15,000,000 40N 081W, 71N 103E, 18N 029W, 29N 026E
Q30 - 1:30,000,000 12N 108W, 07N 125E, 02S 033W, 06S 057E
V1 - 1:02,000,000 BALTIC SEA WEST OF DORNHOLM, BELTS AND SOUND, KATTEGAT.
V2 - 1:02,000,000 62N 004W, 62N 012E,T50N 004W, 50N 012E
V3 - 1:02,000,000 52N 110W, 61N 034E, 07N 057W, 09N 018W
V4 - 1:10,000,000 57N 096W, 71N 071E, 38N 048W, 46N 013E
V5 - GULF OF BOTHNIA AND NORTHERN BALTIC SEA.
V6 - BALTIC SEA PROPER.
V7 - WESTERN BALTIC, BELTS, SOUND, KATTEGAT, SKAGERRAK AND LAKE VAENERN.
V8 - 1:15,000,000 38N 100W, 60N 036E, 14N 070W, 21N 013W
W - 1:12,500,000 64N 067W, 64N 036W,38N 067W, 38N 036W
N - NO INFORMATION CURRENTLY AVAILABLE.

(INFORMATION DATED (08/1991)

NORTHWOOD 1, UNITED KINGDOM

CALL SIGNS	FREQUENCIES	TIMES		EMISSION	POWER
GYA1	2374 kHz	1630-0730	30 SEP-31 MAR	F3C	10 KW
GZZ6	3652 kHz	0000-2359		F3C	10 KW
GZZ2	4307 kHz	0000-2359		F3C	10 KW
GYJ3	6446 kHz	0000-2359		F3C	10 KW
GZZ40	8342.5 kHz	0000-2359		F3C	10 KW
GZZ44	12844.5 kHz	0000-2359		F3C	10 KW
GYA61	16912 kHz	0000-2359	01 APR-29 SEP	F3C	10 KW
		0730-1600	30 SEP-31 MAR	F3C	10 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0300	SCHEDULE	120/576		
0315	SURFACE ANAL	120/576	0000	A
0340	SIGNIFICANT SU WIND & WEATHER PROG	120/576	1800	A
0400	SPECIALS AS REQUESTED	120/576		
0500	SPECIALS AS REQUESTED	120/576		
0600	SELECTED RADIOSONDE OBS	120/576	0000	A
0620	NAC TAFS	120/576		
0630	SURFACE ANAL	120/576	0000	A
0655	COMBINED 0 E & 2 E PROG	120/576	1200	A
0705	SIGNIFICANT SU WIND & WEATHER PROG	120/576	1800	A
0800	GALE SUMMARY	120/576		A
0940	SURFACE ANAL	120/576	0600	A
1030	GALE SUMMARY	120/576		A
1105	SIGNIFICANT SU WIND & WEATHER PROG	120/576	0600	A
1330	SEA & SWELL PROG	120/576	0600	A
1355	SEA SURFACE TEMP	120/576		A
1500	SURFACE ANAL	120/576	1200	A
1525	SPECIALS	120/576		A
1550	SPECIALS	120/576		A
1635	SCHEDULE	120/576		
1645	SELECTED RADIOSONDE OBS	120/576	1200	A
1735	GALE SUMMARY	120/576		A
1800	SURFACE ANAL	120/576	1200	A
1825	SIGNIFICANT SU WIND AND WEATHER PROG	120/576	0600	A
1850	SEA & SWELL PROG	120/576	0600	A

MAP AREA: A - 1:10,000,000 77N 084W, 65N 049E, 32N 044W, 28N 001W

(INFORMATION DATED 05/1991)

Seaquake

Ensign Kurt Shubert
NOAA

At 1526 Pacific Daylight Time, on August 16, 1991, the officers and crew of the NOAA Ship ***McArthur*** experienced a rare phenomenon. The ***McArthur*** was working off the coast of California assessing marine mammal populations in the California current. Having just finished examining a Minke whale, the ship was coming back up to speed when it experienced severe vibrations and a shuddering motion unlike anything anyone on the ship had felt before. The vibrations and shuddering lasted for about 5 to 10 seconds and seemed to be coming from all parts of the ship.

Many on board thought that the watch officer had gone from all ahead full to emergency astern. This action would have caused strong vibrations but nothing of the magnitude that was experienced aboard. Others aboard thought that the propeller shaft had warped or that a blade had been lost. The bridge watch-standers, knowing they had not touched the engine controls except to go to all stop, speculated that there was something wrong with the main engines or that the ship had hit something. Some watch-standers believed the ship had run aground. The last idea was quickly dispelled when the chart and the fathometer were checked and both showed over 1700 fathoms of water beneath the keel. The next thought was that something had been hit, possibly the whale which had just been studied, but no bloody carcass remnants, or any other object was observed in the water.

After dismissing all immediate possibilities, divers were sent under the ship to locate any unseen damage. They found none. No one on board had a firm hypothesis to explain what had happened. It was not until later that evening that the explanation was discovered.

According to a news broadcast from Eureka, California, at approximately 3:30 pm (1530) on the 16th, an earthquake was reported centered 65 miles west of Crescent City, California, registering 6.0 on the Richter scale. The ship's position had been 3 nautical miles and 1700 fathoms from the epicenter of the quake. At first many aboard were skeptical that an earthquake could be felt through 1700 fathoms of dampening water, but after a minimal amount of research in the ship's library, this explanation was accepted.

Earthquakes below the sea which are felt on the surface of the water are termed *seaquakes* and have been documented in the past. Most accounts are taken from ships logs wherein others tried to explain the severe vibrations and motions experienced in ways similar to the hypotheses examined aboard the ***McArthur***. *Richter's Elementary Seismology* (W.H. Freeman and Co., Inc., 1958, pp 117-119) gives several examples wherein other vessels described the experience as similar to running aground, vibrations caused by an anchor chain paying out freely, engine trouble, etc. The immediate sensation is similar to that felt on land, although it is not readily identifiable because the observer is already on an unstable base. So, those of us who spend time at sea are not as immune to feeling an earthquake as we might think, even if it is more of a curiosity than a threat.

We would like to thank Ensign Shubert for the letter. The "Mariners Weather Log" carried a related article entitled "Seaquakes: Shakers of Ships" by former former NOAA Corps Ensign, Frank Rossi in September of 1967 (Vol. 11, No. 5).

Typhoons of the Western North Pacific, 1990

Staff, Joint Typhoon Warning Center

For the western North Pacific, calendar year 1990 became the busiest in JTWC's history– 794 warnings were issued on 32 tropical cyclones. This was slightly more than the climatological mean of 31 tropical cyclones.

While 1990 was near a average year in total tropical cyclones, it was above average for the number of typhoons (17) and super typhoons (4). All the tropical cyclones formed in the monsoon, or near-equatorial trough, even though the Tropical Upper-Tropospheric Trough (TUTT) was much in evidence during the summer. A TUTT is a dominant climatological system and a daily upper-level synoptic feature during the summer season over the tropical North Atlantic, North Pacific and South Pacific Oceans.

January – May

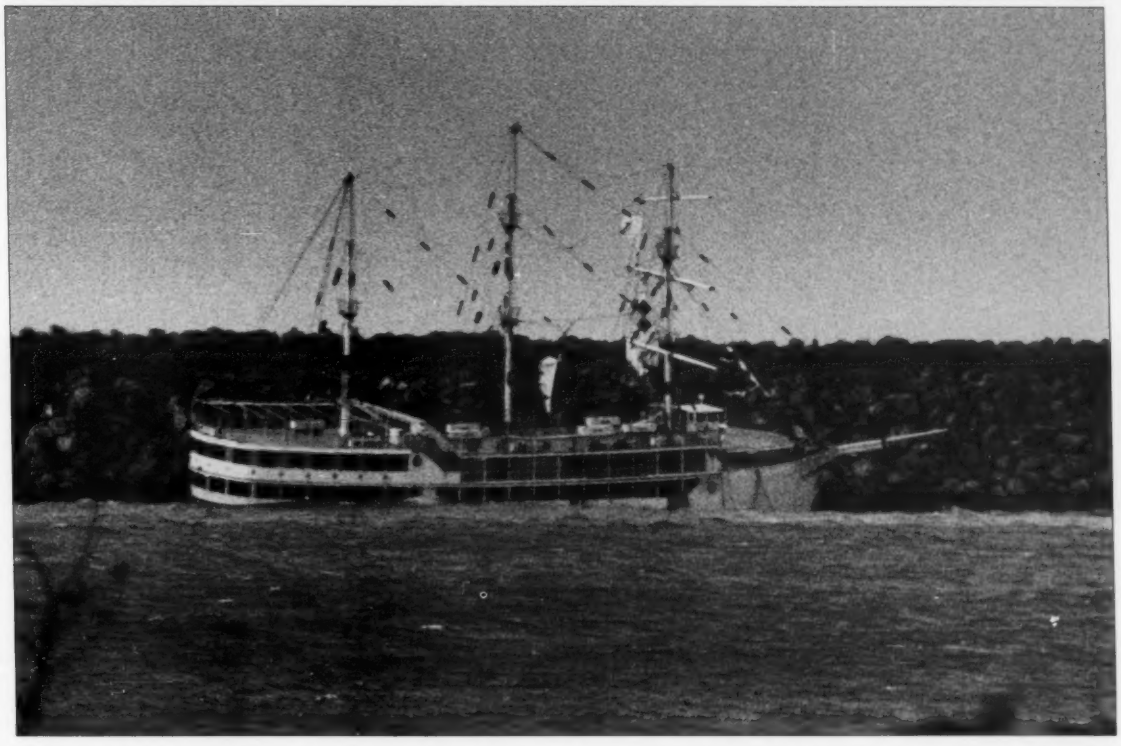
The first tropical cyclone of 1990 in the western North Pacific, **Koryn,** (01W), also became the third typhoon to occur in January in the past 11 years. Unlike Typhoon **Jack** (1988), which came to an abrupt halt and rapidly dissipated just east of Guam, this typhoon turned northward and tracked through the Mariana Islands. **Koryn** brought the strongest sustained winds to the Marianas since **Roy** (1988), another January typhoon. Maximum winds reported at Andersen Air Force Base, Guam were 40 knots gusting to 55 knots, while Naval Air Station Agana reported 54 knots with gusts to 70 knots.

After a three month lull, **Lewis** (02W) developed 200 nautical miles south of Chuuk Island and moved northward, passing directly over the island. After continuing its northward trek for 4 more days, it was sheared apart by a digging mid-latitude trough, and the low-level remnants of the tropical cyclone drifted west-northwestward for several more days before completely dissipating.

Marian (03W) followed and persisted in low latitudes for almost a week before intensifying to become the second typhoon of 1990 and the only significant tropical cyclone to form in May. It tracked from the Philippine Sea across the Philippine Islands and into the South China Sea, where it recurved and merged with a frontal system to form an extratropical low.

June

Following a 1-month break in tropical cyclone activity, Tropical Depression 04W, became the first significant tropical cyclone to form in the South China Sea this year. Because satellite and synoptic fix positions disagreed throughout the depression's life, it proved to be very difficult to locate and forecast. As Tropical Storm **Nathan** (05W) was crossing into the South China Sea, Tropical Depression 04W was drawn into the larger circulation and absorbed. **Nathan,** then executed an abrupt track change and stalled before moving off to the north. Both the track and intensity of TD04W and **Nathan** were dominated by a larger monsoon circulation in the South China Sea. In Hong Kong, according to the *Monthly Weather Summary June 1990*

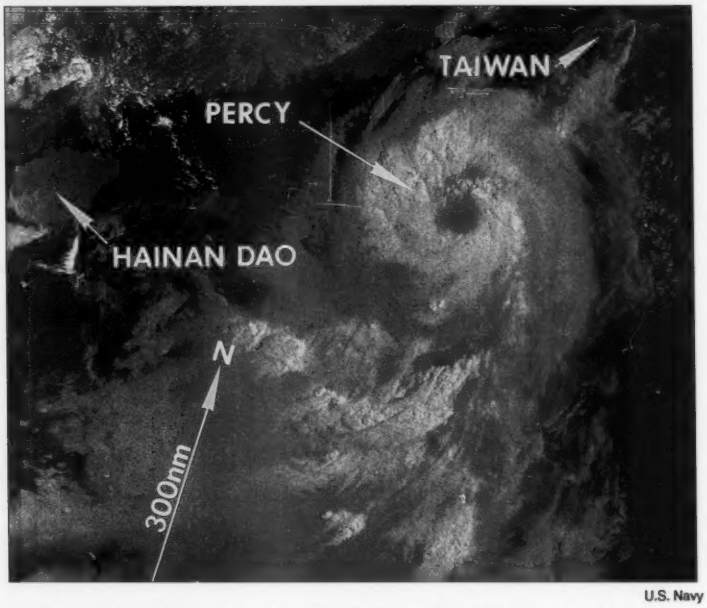


PH1 Jon Hockersmith

The dinner cruise ship **Courageous** *was driven aground on the Glass breakwater in Apra Harbor, Guam, during Typhoon Russ. Photo courtesy of COMNAVMAR Public Affairs/PH1 Jon Hockersmith. This December typhoon was the last of the season and the most severe to strike Guam in 14 years. Damage was estimated as high as $120 million. The island was declared a national disaster area by President Bush on December 24th. Miraculously, no fatalities occurred and only minor injuries were reported. Credit for this was given to disaster preparedness agencies and the communications media. At sea, however, one crewman was lost from a Japanese fishing vessel that foundered southeast of Guam and 10 crew members from a South Korean fishing vessel were lost at sea after their 65-foot boat apparently broke down south of Guam, directly in the typhoon's path. Also, a 220-foot fishing vessel went aground on the breakwater in Apra Harbor.*

published by the Royal Observatory, 13 people were killed, 5 missing and another 15 injured as a result of **Nathan**. The cargo ship ***Tien Fu*** sank in the South China Sea on the 16th, with the loss of the Captain and three of its crew. Two men were reported missing in Macao after being swept overboard from a dredger on the 17th.

Ofelia (06W) became the third typhoon of 1990 and the first for the month of June. It moved toward the Philippine Islands, then slowed and turned to the northwest. It was the second tropical cyclone of the year to strike Taiwan and the first to affect the east coast of China. After recurvature, the extratropical remnants of **Ofelia** crossed Korea, unusual for a June system. **Percy** (07W) followed as the fourth and last tropical cyclone in June. After forming southeast of Guam, it turned on an unusual trek toward the southwest for 36 hours before paralleling **Ofelia's** (06W) west-northwestward move around the western periphery of the subtropical ridge. **Percy** damaged several islands in the western Carolines. The first of these was Sorol, an atoll located 150 nautical miles southeast of Yap. As the tropical storm passed 40 nautical miles to the south of Sorol, the second largest island in the lagoon, Pegelmol, was almost cut in half and another island lost one third of its area due to wave action. In addition, Yap suffered extensive flooding along its eastern shore. Nugulu, 60 nautical miles to the south southwest of Yap took the brunt of the storm, with maximum gusts estimated at 70 knots and all crops totally destroyed. One death was attributed to **Percy** as the storm



U.S. Navy

The ragged, cloud-filled eye of Typhoon Percy (above) at 0100 UTC on the 28th of June reformed after its collision with northern Luzon. Percy was the second storm in less than a week to devastate northern Luzon. The resulting landslides left 8 people dead and more than 31, 000 homeless, adding to the misery left behind by Ofelia.

passed Palau. Once past the Carolines **Percy** became the second typhoon within a week to batter northern Luzon before recurving over eastern China.

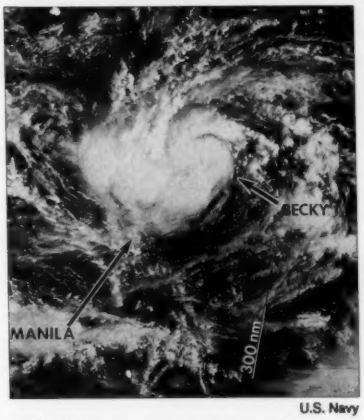
July – October

The first significant tropical cyclone of July, **Robyn** (08W), followed what at first glance might appear to be a typical recurvature path. However, **Robyn's** motion was actually a classic example of the response of a tropical cyclone to the establishment of an omega block in the westerlies to the north, and thus was significant as a case study of an infrequent, but complex, synoptic influence on tropical cyclone motion. The monsoon trough activity substantially increased and **Steve** (09W) along with Tropical Storm **Tasha** (10W) and Typhoon **Vernon** (11W) combined into the only three storm tropical cyclone outbreak to occur in the northwest Pacific this year.

Steve persisted on an atypical northeastward track throughout its existence. **Tasha** (10W), the third of four western Pacific tropical cyclones to occur in July, developed in the monsoon trough, but instead of following **Steve** (09W) and **Vernon** (11W) to the northeast, it made only a brief start in that direction before curving to the west and entering the South China Sea. After erratic motion and slow intensification, **Tasha** finally reached tropical storm intensity before slamming into the southern coast of China, about 75 nautical miles east of Hong Kong on the 31st of July. It caused widespread damage due to torrential rains and flooding in Fujian and Guangdong provinces, where 108 people lost their lives. **Vernon** (11W) followed **Steve's** northward-oriented track, as the monsoon trough underwent a major displacement to the north.

As the first typhoon of 1990 to hit Japan, **Winona** (12W) was the only tropical cyclone to form poleward of 25°N this year. It developed in August from the remnants of Tropical Storm **Tasha** (10W) in a monsoon trough that was displaced northward of its normal location. **Winona** had an unusual track to the southeast before it turned northward to cross the southern portion of the Kanto Plain. In the central Pacific, **Aka** (01C) developed and remained embedded in the trade wind trough. It tracked steadily west-northwestward and never developed beyond tropical storm intensity. **Aka** was the only tropical cyclone of 1990 to be in warning status when it crossed the dateline from the Central into the Western Pacific Ocean.

As **Aka** was dissipating, **Yancy** (13W) generated in the monsoon trough. It became JTWC's best forecast tropical cyclone of the year, and although the track was generally toward the northwest, it contained several interesting features, including interaction with a strengthening subtropical ridge, the effects of a passing mid-latitude shortwave trough and land interaction with the mountainous terrain of Taiwan. Yancy triggered a deep monsoonal surge that resulted in heavy rains and flooding in northern Luzon, leaving at least six people dead. In China the storm was responsible for at least 216 deaths. In the wake of Typhoon **Yancy** (13W), a surge in the southwesterly monsoon flow developed and **Zola** (14W) formed west of Guam in the monsoon trough. The depression initially tracked northeastward in response to a monsoon surge and slowly intensified. **Zola** then broke away from the monsoon trough and



U.S. Navy

Becky (above) reaches minimum typhoon intensity just as it hits northern Luzon at 0039 UTC on the 26th of August. Once again northern Luzon suffered from torrential rains and flooding. Becky was responsible for 32 deaths in Luzon. Later, off Vietnam, three boats and a total of 20 fishermen were reported missing.

intensified to a typhoon. The typhoon recurved over western Honshu, moved into the Sea of Japan and accelerated east-northeastward.

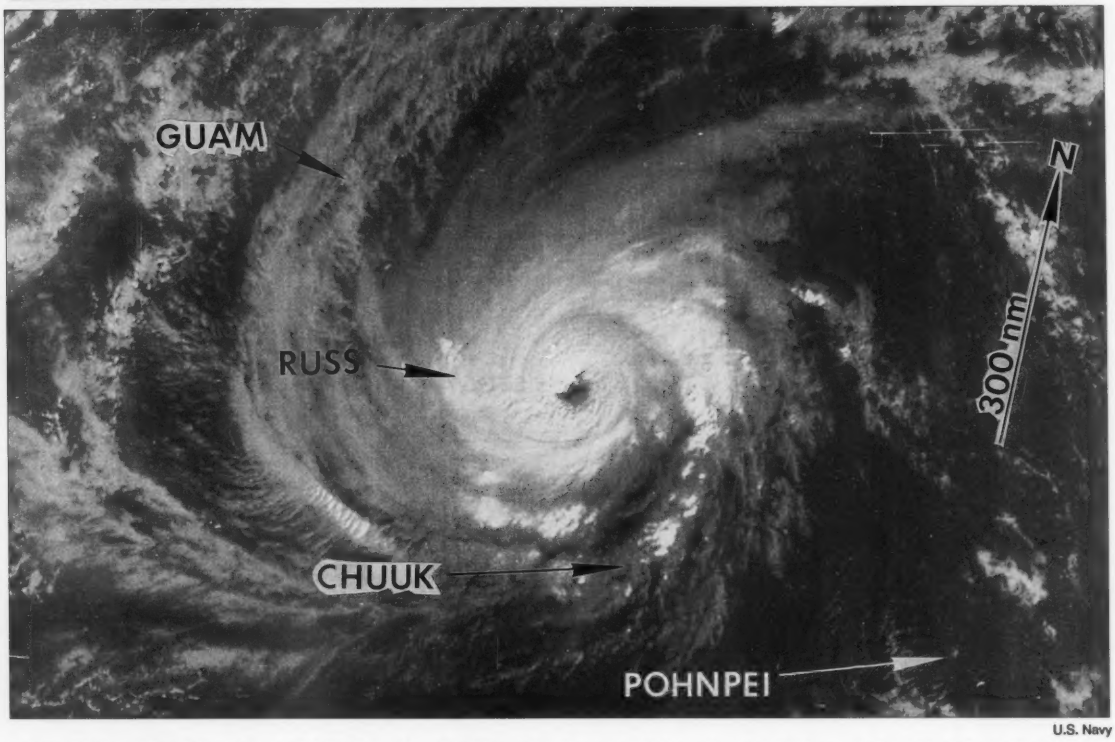
Typhoon **Abe** (15W), the fourth of five tropical cyclones in August, caused extensive damage from the Republic of the Philippines to northern China during its 9-day life. At least 12 people died in Manila and landslides from heavy rains resulted in 32 deaths in the provinces north of Manila. Flooding in Taiwan cost one life while 51 people died in mainland China, near Shanghai. **Abe** was also noteworthy as a classic example of the erratic motion and rapid reorganization that can occur in association with an intense monsoon surge. **Becky** (16W), a midget typhoon and the eleventh typhoon of 1990, generated in the monsoon trough and tracked south of the subtropical ridge throughout its existence. After initially moving west-northwestward, the storm took a southwestward track across the northwestern tip of Luzon before heading westward across the South China Sea. **Becky** hit northern Luzon with typhoon-force winds and later slammed into northern Vietnam as a severe tropical storm.

Dot (17W) developed in the monsoon trough at the same time as Tropical Storm **Cecil** (18W) and brought enhanced southwesterly wind flow and heavy rains across Guam. Later, as **Dot** crossed central Taiwan, torrential monsoon rains from the associated monsoon surge caused extensive flooding in northern Luzon. During its passage across Taiwan and the Fujian Province of China, surface winds in the Formosa Strait exceeded 50 knots for 30 hours. Tropical Storm **Cecil** (18W) was a short-lived, midget tropical cyclone that formed in the wake of Typhoon **Abe** (15W). As **Abe** raced poleward, the monsoon trough reestablished itself over northern Luzon, and **Cecil** formed at the northeast end of the trough. **Cecil** tracked northward and skirted the northern coast of Taiwan before making landfall in southeastern China. **Ed** (19W) formed in the Marshall Islands and continued westward for nearly 2 weeks before finally making landfall in northern Vietnam. It was the third of six tropical cyclones to form in September. **Flo** (20W) was the first of four super typhoons this year, and the object of over 3 consecutive days of upper-tropospheric aircraft reconnaissance missions during the TCM-90 field experiment. **Flo** formed in the wake of Typhoon **Ed** (19W), passed close to Guam, then rapidly intensified into a super typhoon as it approached Okinawa. It recurved slowly before accelerating northeastward towards the Japanese mainland where it was called the most powerful typhoon to hit Honshu in 19 years. At least 38 people were reported dead or missing, and damage was estimated in the millions of dollars. Transportation, communications and power were also disrupted.

Gene (21W) was the fifth significant September tropical cyclone and the fifteenth of the year to reach typhoon intensity. The initial disturbance formed 250 nautical miles west-southwest of Guam and tracked westward for three days before turning northwestward. **Gene** followed a classic recurvature pattern, passing west of Okinawa and skirting southern Japan. As **Gene** moved along the southern coastlines of Kyushu and Honshu, it caused four deaths and local flooding. Winds of 70 knots were measured on Kyushu.

Hattie (22W), the last of six tropical cyclones to form in September, was the fourth tropical cyclone in a 6-week period to affect Okinawa and southern Japan. It also followed a classic recurvature track. As **Hattie** passed 30 nautical miles west of Okinawa, it caused damage in excess of $1.7 million to U.S. military bases. Maximum gusts up to 75 knots were recorded on Okinawa. On a positive note, rainfall from **Flo**, **Gene** and **Hattie** provided 15 to 20 inches of water to fill up almost empty reservoirs.

Ira (23W) was the eighth tropical cyclone to hit Vietnam in 1990 and the last in a series of weak, highly sheared tropical systems in the South China Sea. It formed in a broad area of convection near Palawan Island. The convective cloud mass tracked steadily westward in the deep easterly flow and made landfall at Qui Nhon, Vietnam on the 3d of October. According to the United Press International, the typhoon damaged 110,000 houses and killed seven people in the coastal provinces of Vietnam.



U.S. Navy

Super Typhoon Russ (above) at 2307 UTC on the 18th of December is near peak intensity after the passage of a mid-latitude short wave trough enhanced its outflow aloft. For Guam, Russ was a relatively dry typhoon because the eye wall with its torrential rains passed just to the south. However an estimated $20 million in damage was done to civilian housing and $5 million to the infrastructure. The Port Authority of Guam reported over $100,000 damage to port service equipment, while private businesses estimated damage at $31 million. Military losses were estimated at over $6.5 million.

Jeana (24W), the second of four tropical cyclones to form in October, was the fifth to churn across the South China Sea in 1990. It was difficult to forecast the intensity and track of this minimal tropical storm. **Kyle** (25W) generated from a disturbance in the monsoon trough 600 nautical miles east of Guam. Separating from the trough, the cloud system gained organization and began to track along the southern edge of the subtropical ridge to its northeast. The subtropical ridge and a series of fast moving mid-latitude, short-wave troughs strongly influenced **Kyle's** track. The tropical cyclone passed through the northern Mariana Islands, causing minimal damage, intensified into a typhoon, and recurved. **Lola** (26W), the last of four October tropical cyclones, formed in the South China Sea. It tracked westward along the same path taken by Tropical Storm **Jeana** (24W) 4 days earlier.

November – December

Mike (27W), one of the most intense and destructive tropical cyclones of 1990, caused havoc in the western Carolines and in the central Philippines. Although basically a west-northwestward *straight runner*, it posed numerous forecast challenges due to frequent direction, speed and intensity changes. As a result of the devastation and death in the Republic of the Philippines, Super Typhoon **Mike's** name was retired from the JTWC list of tropical cyclone names. Super Typhoon **Mike** was the most powerful typhoon to strike the Philippines this year and was reported to be the worst to hit the country since 1981. In the central Philippines at least 250 people were reported dead or missing, while over 37,000 houses were destroyed. Cebu City, the commercial and transportation capital of the region, was severely damaged and more than 57 water craft, mostly in the port of Cebu, sank.

On Koror, 45 nautical miles south of Mike's center, extensive damage occurred to boats, greenhouses, aquiculture projects, fruit trees and vegetable gardens. The National Weather Service Office at Koror recorded maximum wind gusts of 72 knots, a minimum sea level pressure of 980.5 millibars and 9.8 inches of rain. Closer to Mike's center, where maximum wind gusts of 135 to 165 knots were estimated, Kayangel Island was almost totally devastated. Many people there lost everything.

Nell (28W), the second of four November tropical cyclones, intensified in the South China Sea and tracked westward, making landfall in Vietnam. **Page** (29W) was the third November storm, the second super typhoon of the month, and part of the three-storm outbreak which included a pair of tropical cyclones near the dateline: **Owen** (30W) in the northern hemisphere and **Sina** (TC 03P) in the southern hemisphere. Persisting as a discrete disturbance for nearly 2 weeks before the first warning was issued, **Page** took only three days to intensify to 140 knots once development commenced.

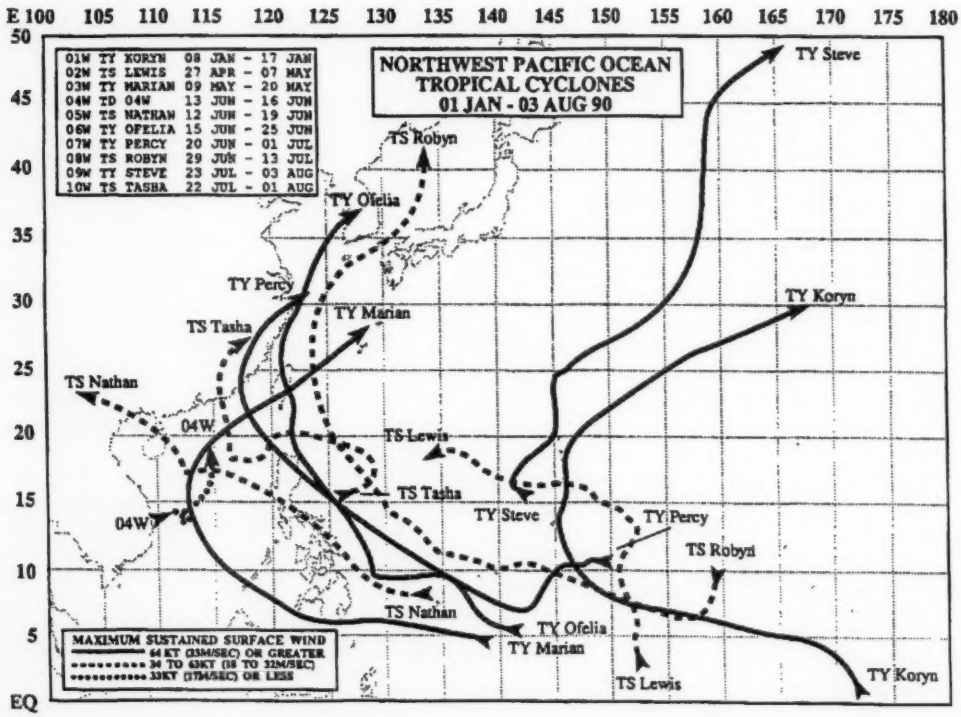
Owen (30W) was both the longest lasting and one of the most interesting tropical cyclones of 1990. It started to rapidly intensify while still a tropical depression, explosively deepened to super typhoon intensity, weakened and then reintensified to a super typhoon. **Owen** started as a discrete cloud mass southwest of Hawaii, maintained its integrity as it tracked westward in the trade wind trough, but did not intensify until it crossed the dateline and passed north of Kwajalein in the Marshall Islands. It then reached typhoon intensity in less than 18 hours and continued westward over the central Caroline Islands until its deep convection was sheared away southeast of Ulithi Island in the western Carolines. The exposed low-level remained organized for 6 more days as it moved north, then west, and finally southwestward before dissipating over the Celebes Sea after crossing Mindanao. **Owen** wreaked havoc in the central Caroline Islands. Several atolls were virtually stripped of houses and crops. In Pohnpei two people were killed by a live power line when it fell. Chuuk State was declared a U.S. federal disaster area and on Pulap Atoll 99 percent of the houses were destroyed. Several locations reported winds in excess of 85 knots.

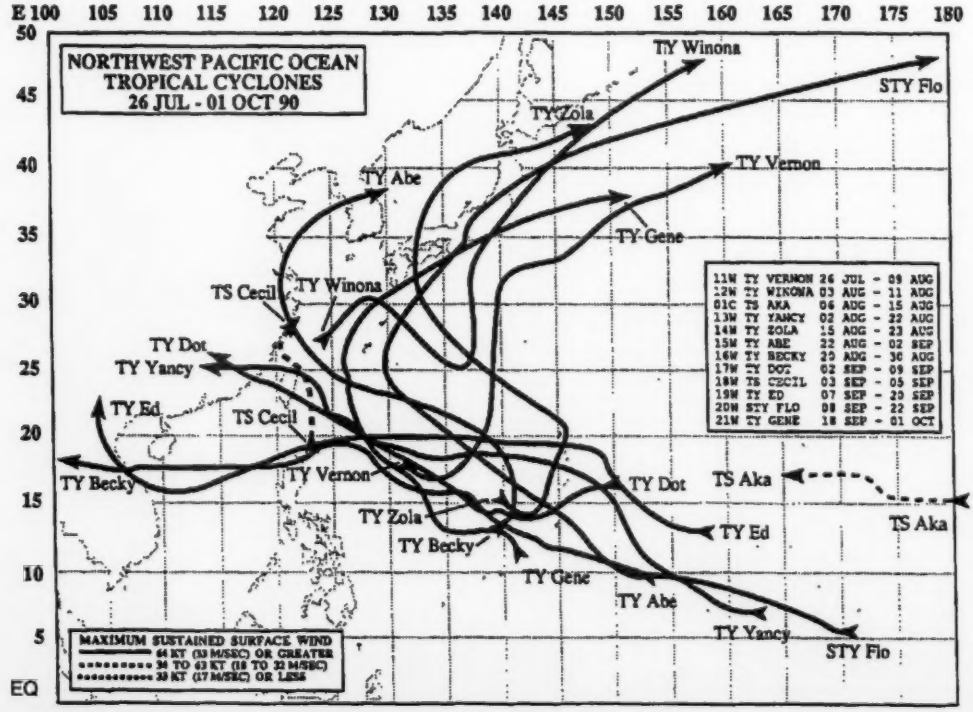
Russ (31W), the last western North Pacific tropical cyclone of 1990, was the most severe to strike Guam in 14 years. Damage was estimated as high as $120 million. **Russ** formed in the Marshall Islands, tracked west-northwestward and intensified to near super typhoon intensity as it approached Guam. The typhoon passed within 30 nautical miles of the southern tip of Guam and brought typhoon force winds, which caused extensive damage, especially to the southern portion of the island. After leaving Guam, **Russ** slowly weakened, recurved and became an extratropical cyclone.

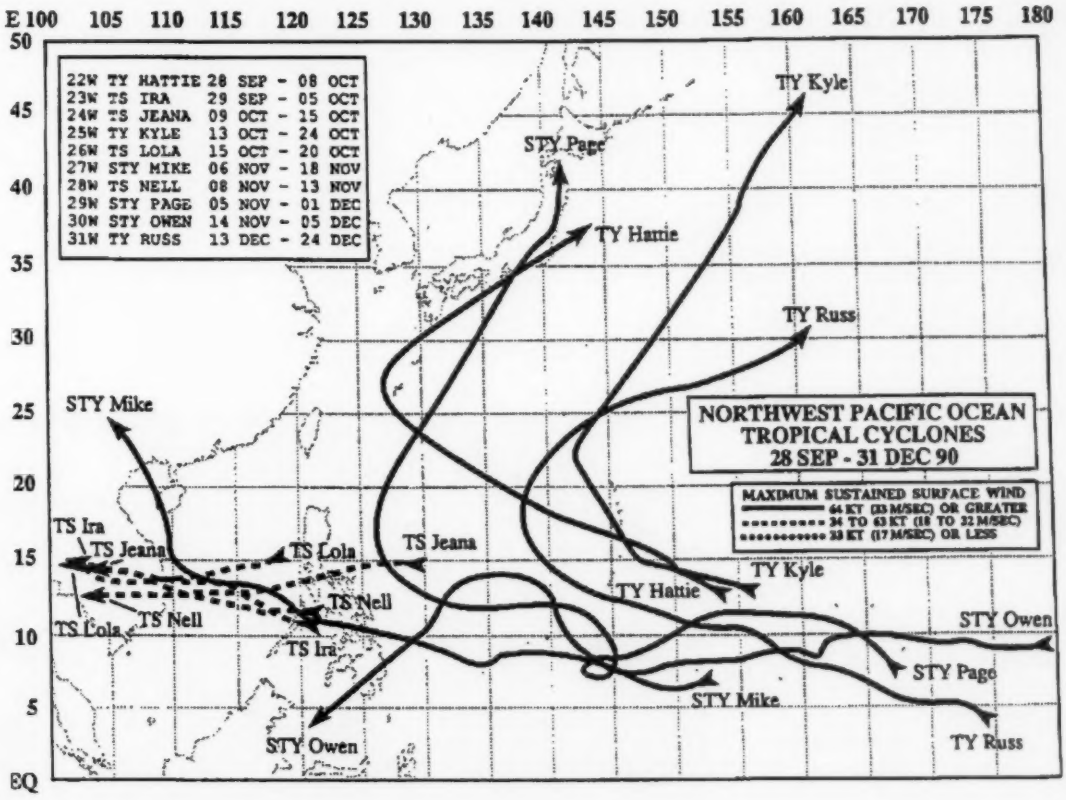
NORTHWEST PACIFIC TROPICAL CYCLONES—1990

TROPICAL CYCLONE	PERIOD OF WARNING	MAX. SFC WINDS KT(M/SEC)	ESTIMATED MSLP (MB)
(01W) TY Koryn	12 Jan - 17 Jan	75(39)	967
(02W) TS Lewis	29 Apr - 03 May	35(18)	997
(03W) TY Marian	15 May - 19 May	90(46)	954
(04W) TD 04W	14 Jun - 15Jun	30(15)	1000
(05W) TS Nathan	15 Jun - 19 Jun	55(28)	984
(06W) TY Ofelia	17 Jun - 25Jun	90(46)	954
(07W) TY Percy	21 Jun - 30 Jun	115(59)	927
(08W) TS Robyn	07 Jul - 11 Jul	45(23)	991
(09W) TY Steve	25 Jul - 02 Aug	115(59)	927
(10W) TS Tasha	28 Jul - 31 Jul	55(28)	984
(11W) TY Vernon	29 Jul - 07 Aug	95(49)	948
(12W) TY Winona	06 Aug - 11 Aug	65(33)	976
(01C) TS Aka*	07 Aug - 15 Aug	45(23)	991
(13W) TY Yancy	13 Aug - 21 Aug	90(46)	954
(14W) TY Zola	17 Aug - 23 Aug	100(51)	944
(15W) TY Abe	24 Aug - 01 Sep	90(46)	954
(16W) TY Becky	24 Aug - 30 Aug	70(36)	972
(17W) TY Dot	03 Sep - 09 Sep	80(41)	963
(18W) TS Cecil	04 Sep - 05 Sep	45(23)	991
(19W) TY Ed	10 Sep - 20 Sep	90(46)	954
(20W) STY Flo	12 Sep - 20 Sep	145(75)	891*
(21W) TY Gene	23 Sep - 30 Sep	80(41)	963
(22W) TY Hattie	30 Sep - 08 Oct	90(46)	954
(23W) TS Ira	02 Oct - 03 Oct	35(18)	997
(24W) TS Jeana	13 Oct - 15 Oct	35(18)	997
(25W) TY Kyle	16 Oct - 22 Oct	90(46)	954
(26W) TS Lola	17 Oct - 18 Oct	40(21)	994
(27W) STY Mike	07 Nov - 18 Nov	150(77)	885
(28W) TS Nell	10 Nov - 12 Nov	50(26)	987
(29W) STY Page	19 Nov - 30 Nov	140(72)	898
(30W) STY Owen	21 Nov - 03 Dec	140(72)	898
(31W) TY Russ	14 Dec - 24 Dec	125(64)	916

* BASED ON AIRCRAFT DATA.


NORTHWEST PACIFIC OCEAN
TROPICAL CYCLONES
01 JAN - 03 AUG 90
01W TY KORYN 08 JAN - 17 JAN
02W TS LEWIS 27 APR - 07 MAY
03W TY MARIAN 09 MAY - 20 MAY
04W TD 04W 13 JUN - 16 JUN
05W TS NATHAN 12 JUN - 19 JUN
06W TY OFELIA 15 JUN - 25 JUN
07W TY PERCY 20 JUN - 01 JUL
08W TS ROBYN 29 JUN - 13 JUL
09W TY STEVE 23 JUL - 03 AUG
10W TS TASHA 22 JUL - 01 AUG
MAXIMUM SUSTAINED SURFACE WIND
64 KT (33M/SEC) OR GREATER
34 TO 63KT (18 TO 32M/SEC)
33KT (17M/SEC) OR LESS
TY Steve
TS Robyn
TY Ofelia
TY Percy
TY Marian
TS Tasha
TY Koryn
TS Nathan
04W
TS Lewis
TS Tasha
TY Steve
TY Percy
TS Robyn
04W
TS Nathan
TY Ofelia
TY Marian
TS Lewis
TY Koryn
E 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180
50 45 40 35 30 25 20 15 10 5 EQ


NORTHWEST PACIFIC OCEAN
TROPICAL CYCLONES
26 JUL - 01 OCT 90
11W TY VERNON 26 JUL - 09 AUG
12W TY WINONA 03 AUG - 11 AUG
01C TS AKA 06 AUG - 15 AUG
13W TY YANCY 02 AUG - 22 AUG
14W TY ZOLA 15 AUG - 23 AUG
15W TY ABE 22 AUG - 02 SEP
16W TY BECKY 29 AUG - 30 AUG
17W TY DOT 02 SEP - 09 SEP
18W TS CECIL 03 SEP - 05 SEP
19W TY ED 07 SEP - 20 SEP
20W STY FLO 08 SEP - 22 SEP
21W TY GENE 18 SEP - 01 OCT
MAXIMUM SUSTAINED SURFACE WIND
64 KT (33 M/SEC) OR GREATER
34 TO 63 KT (18 TO 32 M/SEC)
33 KT (17 M/SEC) OR LESS
TY Winona
STY Flo
TY Zola
TY Vernon
TY Abe
TY Gene
TS Cecil
TY Winona
TY Dot
TY Yancy
TY Ed
TS Cecil
TY Becky
TY Vernon
TY Dot
TS Aka
TY Zola
TY Ed
TS Aka
TY Becky
TY Gene
TY Abe
TY Yancy
STY Flo
E 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180
50 45 40 35 30 25 20 15 10 5 EQ


E 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180
50 45 40 35 30 25 20 15 10 5 EQ
22W TY HATTIE 28 SEP - 08 OCT
23W TS IRA 29 SEP - 05 OCT
24W TS JEANA 09 OCT - 15 OCT
25W TY KYLE 13 OCT - 24 OCT
26W TS LOLA 15 OCT - 20 OCT
27W STY MIKE 06 NOV - 18 NOV
28W TS NELL 08 NOV - 13 NOV
29W STY PAGE 05 NOV - 01 DEC
30W STY OWEN 14 NOV - 05 DEC
31W TY RUSS 13 DEC - 24 DEC
NORTHWEST PACIFIC OCEAN
TROPICAL CYCLONES
28 SEP - 31 DEC 90
MAXIMUM SUSTAINED SURFACE WIND
64 KT (33 M/SEC) OR GREATER
34 TO 63 KT (18 TO 32 M/SEC)
33 KT (17 M/SEC) OR LESS
TY Kyle
STY Page
TY Hattie
TY Russ
STY Mike
TS Ira
TS Jeana
TS Lola
TS Jeana
TS Nell
TS Nell
TS Lola
TS Ira
STY Owen
TY Kyle
TY Hattie
STY Owen
STY Page
STY Mike
TY Russ

Joint Typhoon Warning Center

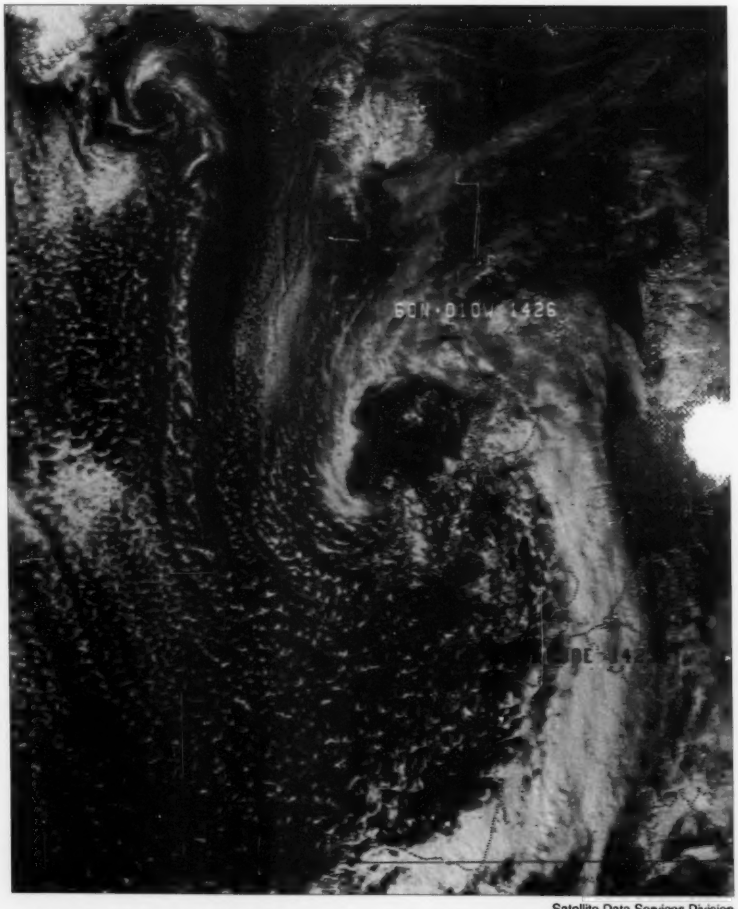
The Joint Typhoon Warning Center's summary for the Mariners Weather Log has appeared every year since 1959 (the 1958 summary). They have been one of the best and most important contributors to the Log. This summary is, however, just the tip of the iceberg as far as the wealth of information that is contained in the **Joint Typhoon Warning Center's Annual Tropical Cyclone Report**. This informative report contains information on warnings, fixes, forecasting details, and specific summaries for each storm as well as a detailed track for each storm and other climatological and operational information. It also contains a summary for the North Indian Ocean and the South Pacific and South Indian Ocean. Literally, it is a gold mine of information. We use the reports back to 1959 all the time and this year's format is the best we have seen. Copies of these reports are available from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

North Atlantic Weather April, May and June 1991

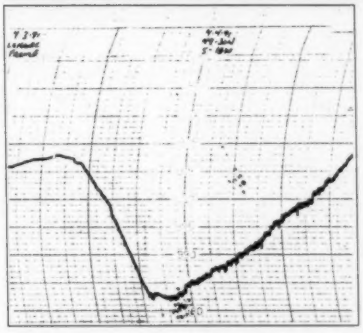
April– The Azores–Bermuda High was aptly named this month as both regions showed positive anomalies up to 6 mb and covered nearly the entire ocean with higher than normal pressures. The minor exceptions were in the Norwegian and Labrador Seas. Higher than normal pressures usually bode well for mariners.

An interesting situation developed northwest of Ireland from the 4th through the 6th, when a couple of 964–mb Lows stirred these waters. One system popped up north of Bermuda on the 3d, while an earlier one had developed in the same general area on the 1st. Both moved east northeastward and intensified. They were followed a short time late by another Low that had come to life southwest of Iceland on the 3d and proceeded to turn a counterclockwise loop. By the 6th, it was a 970–mb Low just north of the second Bermuda Low. Several vessels experienced weather from these systems. Both the ***Mathilde Maersk*** (49N, 23°W) and the ***Lindoe Maersk*** (55°N, 25°W) hit 40–kn winds in 20– to 25–ft seas on the 6th. Farther east, the ***Star Eagle*** (48°N, 14°W) ran into a 47–kn westerly in 20–ft swells. Activity continued



Satellite Data Services Division

This shot, on the 4th of April, shows a potent Low west of Ireland. The system actually developed at the end of March but caused havoc this month. Its strong cold front trailed through the English Channel and into the Bay of Biscay.

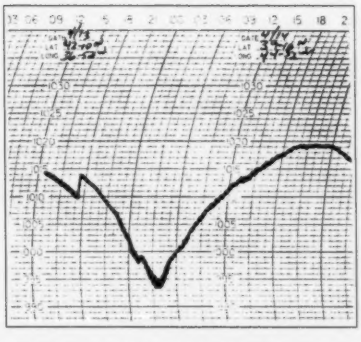


*This barograph from the **Ile de France**, which was sailing from Rotterdam to LeHavre, shows its view of the storm on the 4th, near 49.5°N, 5.3°W.*

over the eastern North Atlantic in the form of several weaker systems that moved through these waters during the first half of the month.

A Low intensified on the 15th, near 38°N, 47°W. After moving toward the northeast, it swung southeastward than eastward, moving south of the Azores. It finally ended up on over Morocco on the 21st. The system was picked up by the ***Margaret Lykes***. She was at 39°N, 42°W on the 17th and ran into a 53-kn west northwesterly in 21-ft seas.

Cyclonic activity shifted during the second half of April and several weak to moderate systems produced some rough weather



*This barograph from the **Tillis Lykes**, which was sailing from LeHavre to Norfolk, picked up the beginning of the Morocco storm on the 14th.*

between New England and Iceland. Most of these storm were short-lived. For example, a 965-mb Low developed off Newfoundland on the 25th. It moved northeastward and 24 hr later the central pressure had risen to 987 mb. While there was no lack of cyclonic activity, high pressure systems continued to move in and dominate the weather scene. On the 22d, a large 1035-mb High out of Labrador moved southeastward and eventually settled over the Azores until the end of the month. This was joined by a 1024-mb High from off the Delmarva Peninsula on the 26th, which meandered north of Bermuda.

Casualties— In thick fog a scene reminiscent of *Danie's Inferno* took place in the waters of Leghorn, Italy on the night of the 10th. The Italian ferry ***Moby Prince*** collided with the oil-laden tanker ***Abruzzo***, which was anchored. Some 141 people died in one of Europe's worst ferry disasters. The ferry was sailing from Leghorn to Sardinia with 74 passengers and a crew of 68. Only one person, a crewman, survived from the ***Moby Prince***, while all 28 crewmen of the ***Abruzzo*** were able to escape the fiery blaze.

On the 15th the Norwegian ferry ***Narvik*** with 140 passengers ran aground on the Norwegian coast in bad weather. No one was injured and the passengers were taken off.

May— We might call it the Irish-Azores High for this month of May. Between the Azores and Ireland pressure was up to 16 mb higher than normal for this time of the year. In fact, these positive anomalies covered the entire northeastern Atlantic east of 40°W. As a result, the low pressure systems that did form were squeezed into the Denmark St. So an average storm track for the month can be quite easily drawn from the Grand Banks to the Denmark St. Most of these systems had a central pressure of 990 mb or above, which is not unusual for this time of the year. With the high pressure systems so strong, however, gradients in the mid ocean were fairly tight and gales and heavy seas were occasionally generated in these waters throughout the month.

The ***Freedom Export***, on the 4th, ran into 40-kn winds in 20-ft swells. This was south of a short-lived system that came to life some 300 mi to the north. The Low moved across Labrador the following day. While there was no lack of gale reports during the month, most were scattered, and there were very few apparent prolonged periods of rough weather. On the 20th and 21st several vessels and rigs reported 40- to 60-kn winds in the North Sea as a frontal system from a Norwegian Sea Low swept through the area. The USNS ***Bartlett*** (59°N, 12°W) at 1200 on the 21st ran into a 50-kn westerly in 33-ft swells. The most potent storm of the month formed on the 28th off Nova scotia. By the 30th its central pressure was down to 991 mb and 24 hr later it plummeted to 968 mb. Several vessels were reporting 40- to 50-kn winds. The JMLC, near 42°N, 46°W, encountered 56-kn westerlies (measured) in 26-ft seas. The storm continued to remain potent as the month came to a close.

Casualties— The biggest shipping related disaster in the Northern Hemisphere occurred at the end of April and spilled over into the beginning of May. A potent cyclone devastated Bangladesh on

Satellite Data Services Division

On the 25th of June, the 978-mb storm is south of Newfoundland at about 1630. It generated gales and rough seas over the northwestern shipping lanes. However, it was a short-lived system and soon began to dissipate as it headed northward.

the last day of April and was followed by monsoonal rains, which left the region a shambles. The death toll was expected to be about 200,000. On the marine side the port at Chittagong was strewn with vessels that were sunk, partially sunk or aground. These included tankers, barges, dredges and fishing vessels. There were also several Bangladesh naval vessels that were damaged or sunk.

June– At first glance it looks like just another ordinary June with the Azores-Bermuda High in place and all's well. However, two strong Lows can be seen on the climatic charts, one over the Labrador Sea and the other over the Norwegian Sea. These two features generated negative anomalies of 4 to 6 mb from the Gulf of St. Lawrence to the Baltic. A look at the storm tracks for the month indicates that it would be easy to draw an average path from New England to the North Sea.

The storm that formed at the end of May appears at 45°N, 47°W on the first June chart. The system proceeded to turn a counterclockwise loop over Newfoundland and then move in an easterly direction along the 50th parallel, finally ending up in the English Channel on the 7th. It never quite regained the 965-mb intensity that it had achieved at the end of May, but it still caused trouble along the way. The LAWO2 (41°N, 43°W) and the FENF (50°N, 41°W) caught 40- to 45-kn winds in swells of 16 to 20 ft on the 1st.

Another potent system came to life over northern Labrador on the 7th. After turning a counterclockwise loop in the Labrador Sea, it traveled east northeastward and intensified on the 10th. By the 11th, it was a strong 977-mb Low steaming toward northern Scotland. The ESHW (53°N, 27°W), at 1800 on the 11th, measured 50-kn winds in 20-ft seas. The following day several vessels reported winds in the 40-kn range as the storm moved into the Norwegian Sea.

One other interesting June Atlantic storm actually began life in northern Nevada on the 19th. After moving across the heartland of the U.S., it crossed the coast near Norfolk, VA. Once into the friendly confines of the Atlantic, the storm began to intensify. By the 25th, its central pressure was down to 978 mb near 42°N, 56°W. The ZCAK2 (42°N, 57°W) reported a 64-kn wind and ¼ mi visibility in 33-ft seas and rain. Six hr later her winds dropped to 47 kn and seas were running 30 ft. The storm headed northeastward and began to fill on the 26th.

Casualties– None were reported. However, there was a report of interest involving the Caspian Sea. This sea was reported rising along it southwestern coast and 250 families had to evacuated from threatened homes in the port of Bandar Anzali. Soviet statistics showed that the Caspian had been rising since 1977. This most recent rise was probably caused by the greater inflow from the Volga and other Soviet rivers.

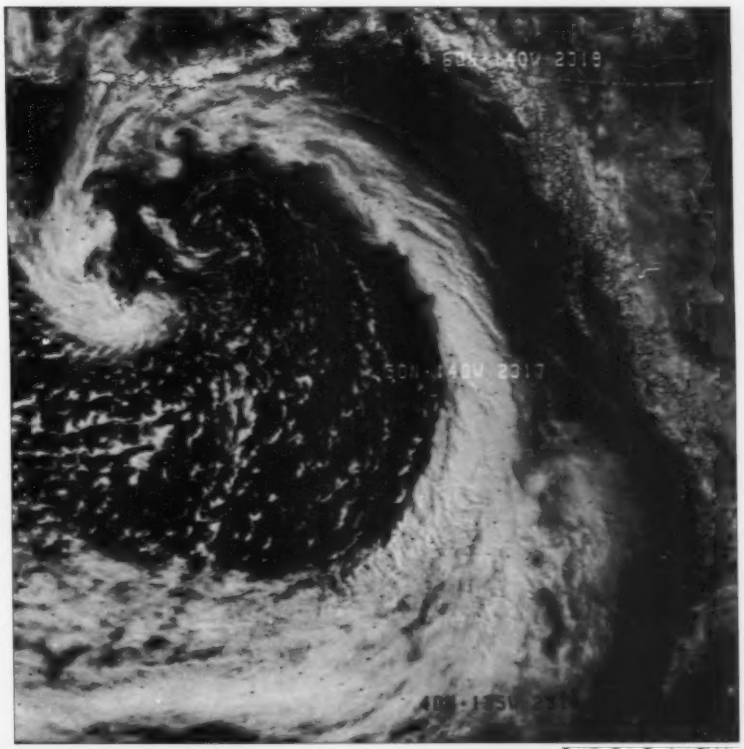
You may notice a new look to the Marine Weather Review. Time constraints have forced us to reduce these summaries to a brief overview, and in time we may lose them altogether. In that case we will expand the Gale Tables so that not too much information is lost. We have also gone back to mb designation of pressure, since it is less confusing. All times unless noted are UTC (universal time) and all miles are nautical. Tropical Cyclones, for the most part, will be covered in the annual reports from the tropical cyclone centers around the world. The weather summaries are based upon the track charts and Northern Hemisphere Surface Charts as well as ship reports. The track charts are provided by NMC. For a long time they have been drawn by the team of James Dodge and George Tisdale. However, Jim is now retiring so this fine team will be broken up. In fact, neither will be working on this unique product, but, hopefully, it will continue. The Log is one of the few publication that has a lengthy history of extratropical storm tracks. We would like to take this opportunity to thank Dodge and Tisdale for their dedication and wish Jim a happy retirement.

–ed.

North Pacific Weather April, May and June 1991

April– The classic springtime situation can be seen on this month's climatic charts, as the Aleutian Low battles for control with the subtropical Pacific High. This year the Low had the upper hand, but only slightly. The result was negative 6-mb anomalies over the northeast Pacific, although a northward bulge of the High produced some slight positive anomalies along the Pacific Northwest coastline. Cyclonic action stretched from Honshu to the Gulf of Alaska.

The month opened with a relatively intense storm moving along the Aleutians. On the 1st, the center was at 973 mb and by 1200 on the 2d it had deepened to 960 mb as it headed toward the



Satellite Data Services Division

This 960-mb storm caused problems for shipping from the 2d through the 4th. The photo was taken on the 2d and shows its strong frontal system.

Satellite Data Services Division

This is part of a complex system, which eventually crossed the coast north of the Queen Charlotte Islands on the 13th. The photograph was taken on the 9th of April, which was about the same time a cold wave was arriving over western Washington.

Gulf of Alaska. It remained particularly potent from the 2d through the 4th. This was borne out by a slew of ship reports from vessels such as the ***Neptune Amber***, ***Hanei Sky***, ***Marie Maersk*** and ***Sea-Land Tacoma***. Winds reported by these vessels ranged from 40 to 50 kn in 20-to 25-ft seas. The system filled rapidly on the 5th and 6th.

On the 9th at 1800, the ***Jovian Lily*** (46°N, 162°W) picked up a 50-kn easterly in 20-ft swells. She was northeast of a 968-mb Low, which began kicking up its heels after crossing the dateline on the 8th. This system remained intact, but weakened as it swung northeastward and moved across the British Columbia coast, north of the Queen Charlotte Islands on the 13th. On the 15th and 16th, a 972-mb Low east of the Kamchatka Peninsula was encountered by such vessels as the ***Rubin Ocean***, ***New Duquesa*** and ***Arctic Tokyo***. They hit 45- to 55-kn winds in 20-to 23-ft swells, southwest through southeast of the center. A few days later, on the 18th, the ***Hanjin Kusan***, ***Sea Bells*** and ***Florida Rainbow*** were hit by 40- to 50- kn winds from another 972-mb storm along the Aleutian Islands. Then, toward the end of the month, a 988-mb Low in the Gulf of Alaska triggered gale reports from the ***Aspen***, while a 976-mb Low off Hokkaido generated storm force winds as attested to by the ***Pacific Emerald*** and the 26-ft swells encountered by the ***Bay Bridge***.

Casualties— On the 9th an unseasonably cold air mass moved out of the Gulf of Alaska and over western Washington. In addition, a local weather feature known as the Puget Sound Convergence Zone developed between Seattle and Everett. The combinations of these two features resulted in unsettled weather conditions including a tornado over Kitsap County. There was damage to six houses and numerous trees. While there was no marine damage reported, by our usual sources in the North Pacific, the South Indian Ocean was the site of a potential disaster. The Hong Kong registered ***Mineral Diamond***, a 141,000-ton bulk carrier had failed to make radio contact for 3 days. It was last heard from on the 17th, near 30° 21'S, 87° 48'E. The last message indicated that the vessel had slowed down to 6 kn in heavy weather; 20-ft swells and force 9 to 10 winds were being generated by a cyclone north of the vessel. Her destination was Dampier the same as that of the ***Alexandre P***, which was lost in the Indian Ocean just over a year ago.

May— The climatic battle for control of the Pacific between the Aleutian Low and the subtropical Pacific High continued in May. The anomalies showed that, once again, the stubborn Aleutian Low refused to give in, spreading negative anomalies of 4 mb from Kamchatka to the Alaskan Peninsula. However, the subtropical high took control of the east, which resulted in +4-mb anomalies from the Gulf of Alaska southward. The track chart does not clearly reflect what appears on

the climatic charts, as moderate cyclonic activity seems to be everywhere north of 40°N. However, the lows were mostly 990 mb and above. A track chart of anticyclones shows a concentration of these systems off the coast of California.

The month opened with a trans-Pacific Low that formed off Honshu on the 1st and made landfall across Vancouver Is and into British Columbia on the 7th. In between, it meandered across the southern Bering Sea and reached peak intensity on the 5th when central pressure dropped to 968 mb. At 0000 on the 6th, the WEZM provided some verification when she reported 40-kn winds in 23-ft swells near 47°N, 174°E.

At the end of April, a Low from off Tokyo had made its way across the Pacific. It intensified into a 978-mb storm near 45°N, 170°W, as the month closed. This is what greeted the ***San Mateo Victory***, ***Sea-Land Liberator*** and ***Mette Maersk***, on the 1st, when they encountered 40- to 48-kn winds. The ***Mette Maersk*** (46°N, 170°W) hit 33-ft seas as well. The storm, however, was short-lived in May and fizzled by the 3d.

Adding to the early May chaos in the Pacific was another system, which had developed off Honshu as April was coming to a close. At the end of the month it was a 976-mb Low near 43°N, 152°E. It remained an organized moderate system for the first week in May, as it moved across the Bering Sea and Alaskan Peninsula, before finally coming ashore over southeastern Alaska on the 7th. The EOCQ (58°N, 173°E), at 0600 on the 4th, was blasted by 48-kn northerlies, while 12 hr later the EMJW ran into 45-kn southwesterlies near 54°N, 167°W.

After this hectic start, weather conditions improved somewhat over the next several weeks, as several large Highs meandered along the 40th parallel. A Low that had developed near 40°N, 155°E, on the 13th, was responsible for a report from the ***Ever Goods***, on the 15th, near 44°N, 177°E. She encountered 47-kn west southwesterlies in 33-ft swells as the 990-mb storm tracked north of her position. The system finally moved into the Gulf of Alaska on the 19th, but was dissipating rapidly by this time.

Ex-Typhoon Walt created few problems in its extratropical stages on the 17th and 18th. The little cyclonic activity during the second half of the month took place mainly in the Sea of Okhotsk and the Bering Sea. From the 19th through the 27th a large 1030-mb High moved off the Alaskan Peninsula and then over the northeastern North Pacific.

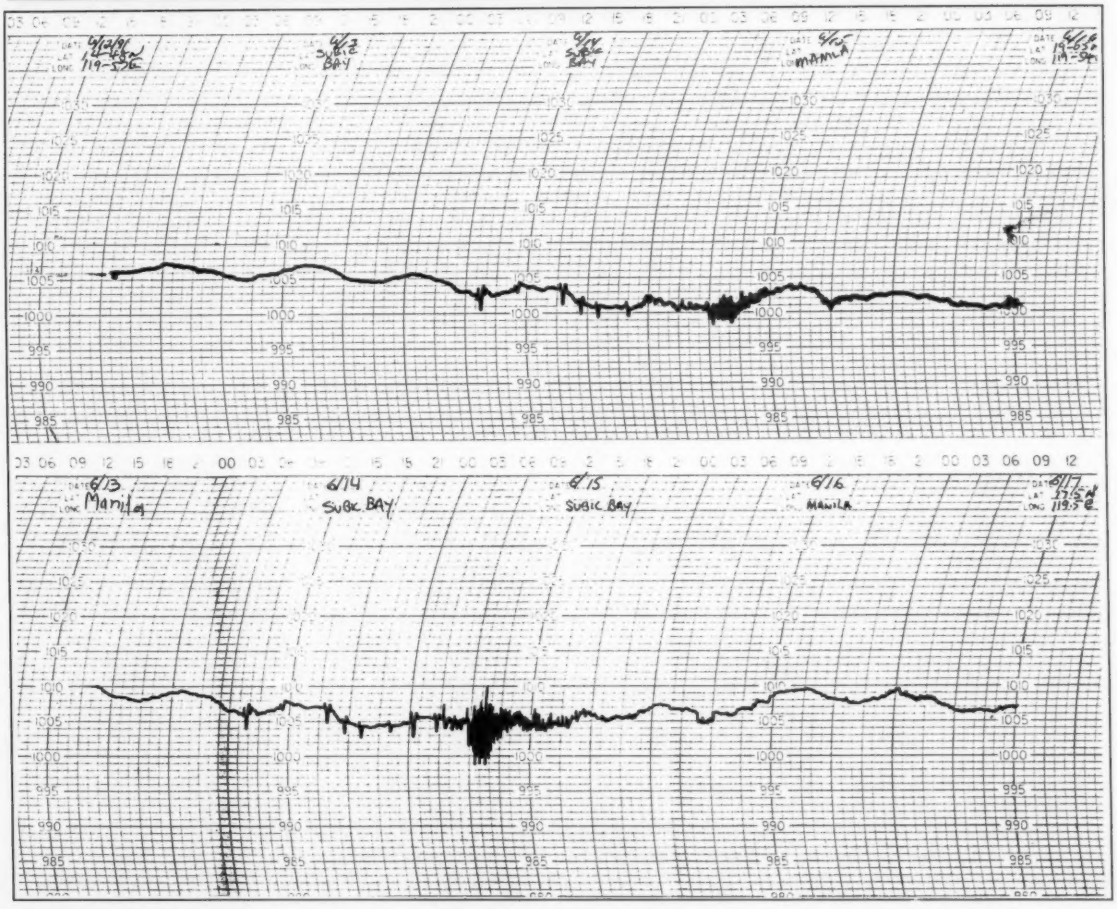
Casualties— None reported in our sources.

June— The subtropical Pacific high was not only in control of the Pacific in June, but the Aleutian Low all but disappeared from view. Its weak 1012-mb center can be found cowering in Bristol Bay. This resulted in Pacific-wide positive anomalies of up to 6 mb, north of 40°N. Storm tracks were, in general, spread out across the Pacific, but only a few lows had centers that intensified below 990 mb.

The most significant storm of the month was a trans-Pacific system that began near Tokyo on the 3d and finished up over the Queen Charlotte Islands on the 10th. On the 5th, its center crossed the 45th parallel, sporting a 972-mb reading near 170°E. The ***Prince of Tokyo 2*** typified conditions on the 5th and 6th when she reported 45- to 50-kn winds in 20- to 30-ft swells. During this period she was sailing north through northwest of the center and her visibility was down to 1 mi. On the 7th, the east northeastward moving system began to fill, but made a brief comeback on the 9th, when it intensified once again to 972 mb. This was short-lived and the system filled quickly as it made its way toward landfall.

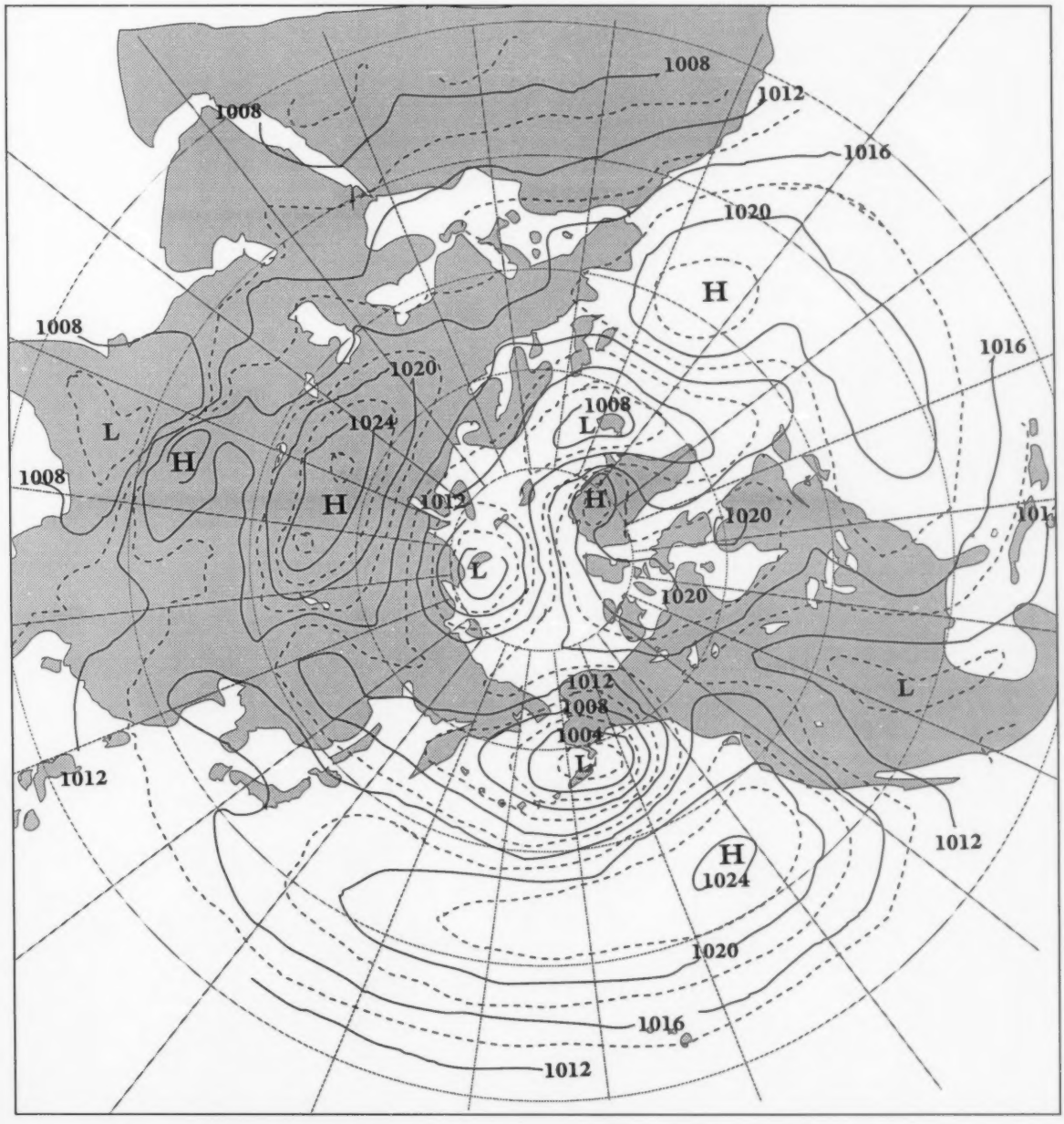
That was about the end of prolonged rough weather over the northern shipping lanes in June. A complex 982-mb system was analyzed on the 20th, near 40°N, 175°E. It had developed near 35°N and the dateline, on the 16th, and joined another Low that had formed to the west on the 17th. This combined 990-mb Low swung northeastward toward the Alaskan Peninsula. By the 23d, it was preempted by another 990-mb Low that had come to life off Honshu on the 20th. This flurry of activity was responsible for the weather that beset the ***Sea-Land Kodiak*** on the 23d. She reported 40-kn southerlies in 20-ft swells near 53°N, 154°W.

Casualties— Typhoon Yuna brought torrential rains to central Luzon. This rain mixed with volcanic ash bursting from Mt Pinatubo and created a heavy muck, which destroyed many buildings and houses. Hundreds of people were reported killed or injured. The Mt Pinatubo eruption is also expected to have long-term global climatic effects. These include the possibility of warming. On the following page are barographs submitted by two of our observing ships that were in Manila at the time of the eruption. Remember, that in the tropics there is very little pressure fluctuation in a normal day.



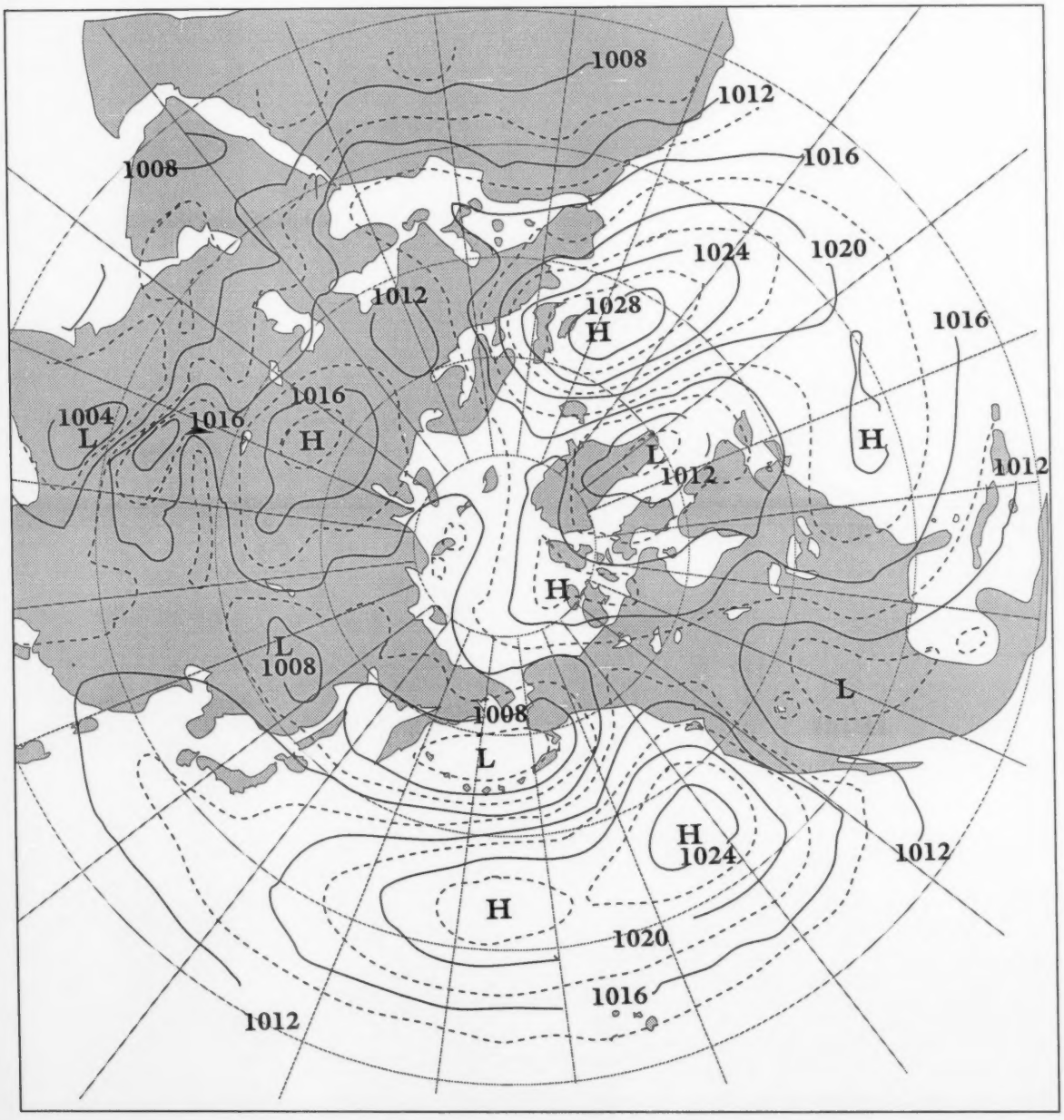
The two barographs received depict the pressure variations during the eruption of Mt. Pinatubo volcano in the Philippines in June. 3/M Darrell Young aboard the ***Sea-Land Pacer*** *(top barograph) added some notes as well. At 0000 on the 13th, the first major eruption occurred. The vessel was docked in Manila at the time and the eruption was visible from the ship. From about 0800 on the 13th to 0500 on the 15th they observed volcanic dust and ash falling on the ship. During this period there were more eruptions and they also encountered thunder, lightning and heavy rain. While they were anchored in Manila Bay, at about 0700 on the 15th, Typhoon Yuna passed within about 50 mi of their location. Once again, at about 1200, heavy volcanic ash fell while they were at dock in Manila; the wind was about force 5 at this time. The lower chart was submitted by 2/M Richard Vohs of the* ***President Madison****. They were also in Manila and Subic Bay during the eruption and ended up with about 4 to 5 in of volcanic ash on their decks. Thanks to both these gentlemen for sending in their barograph charts and reports.*

April 1991



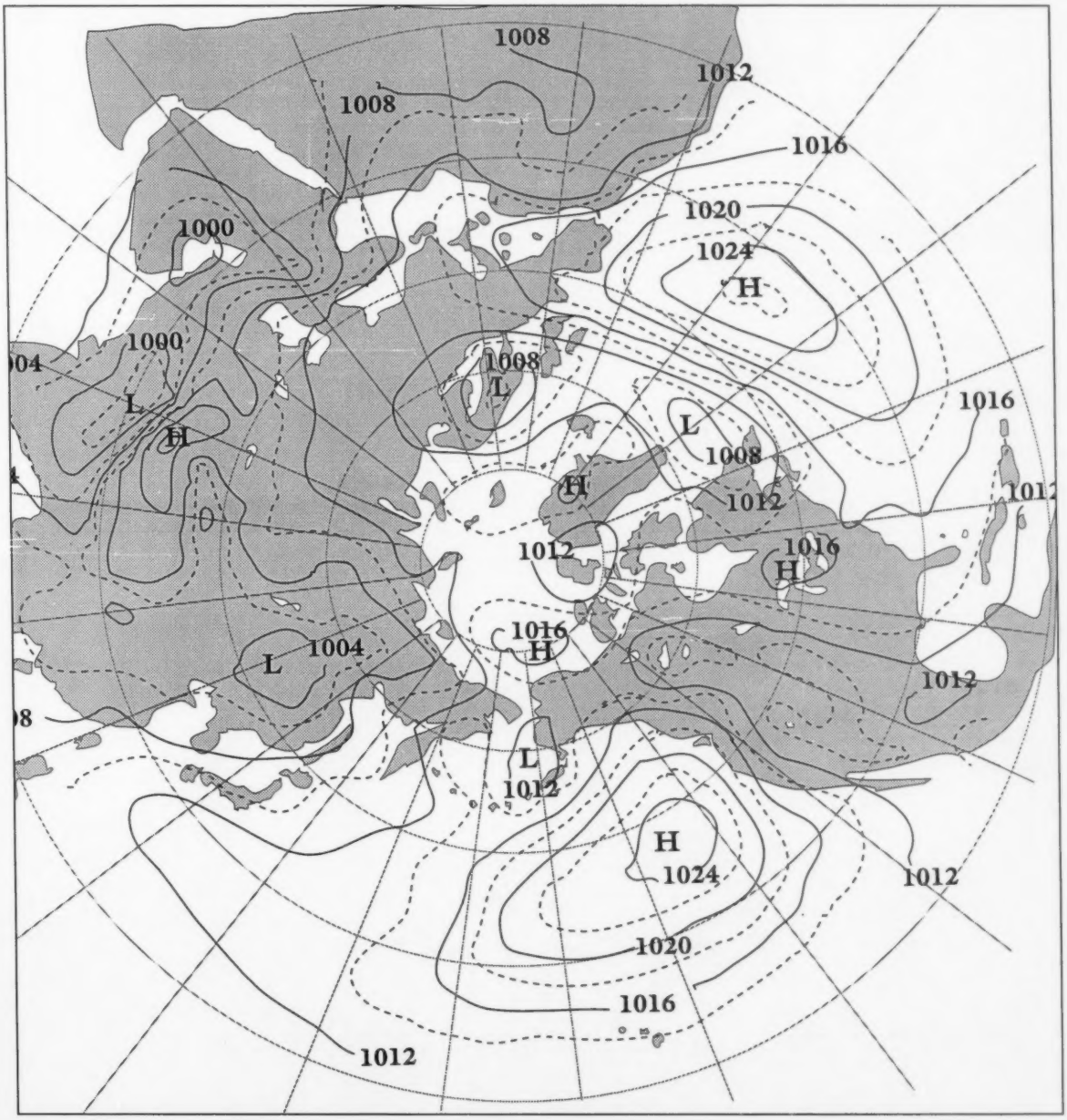
These Charts were Provided by John Kopman and Vernon Kousky of the Climate Analysis Center from the *Climate Diagnostics Bulletin.*

May 1991



These Charts were Provided by John Kopman and Vernon Kousky of the Climate Analysis Center from the *Climate Diagnostics Bulletin*.

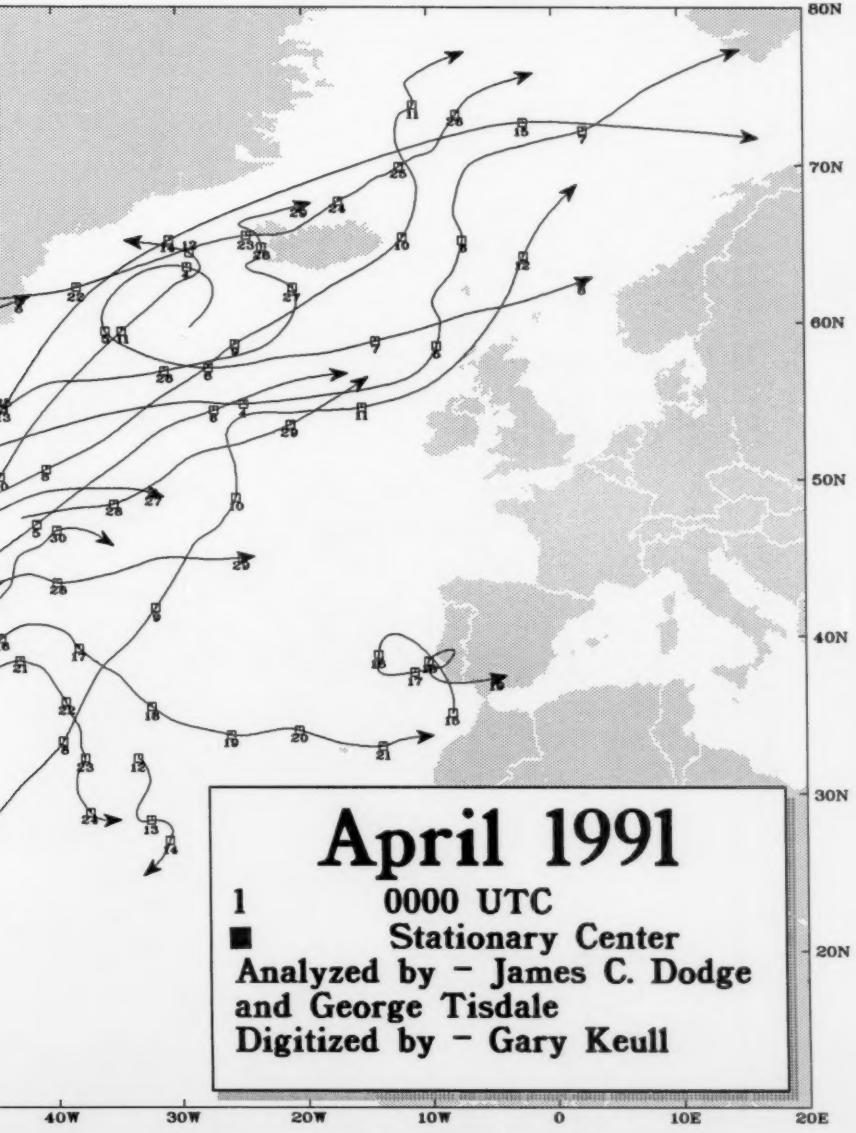
June 1991



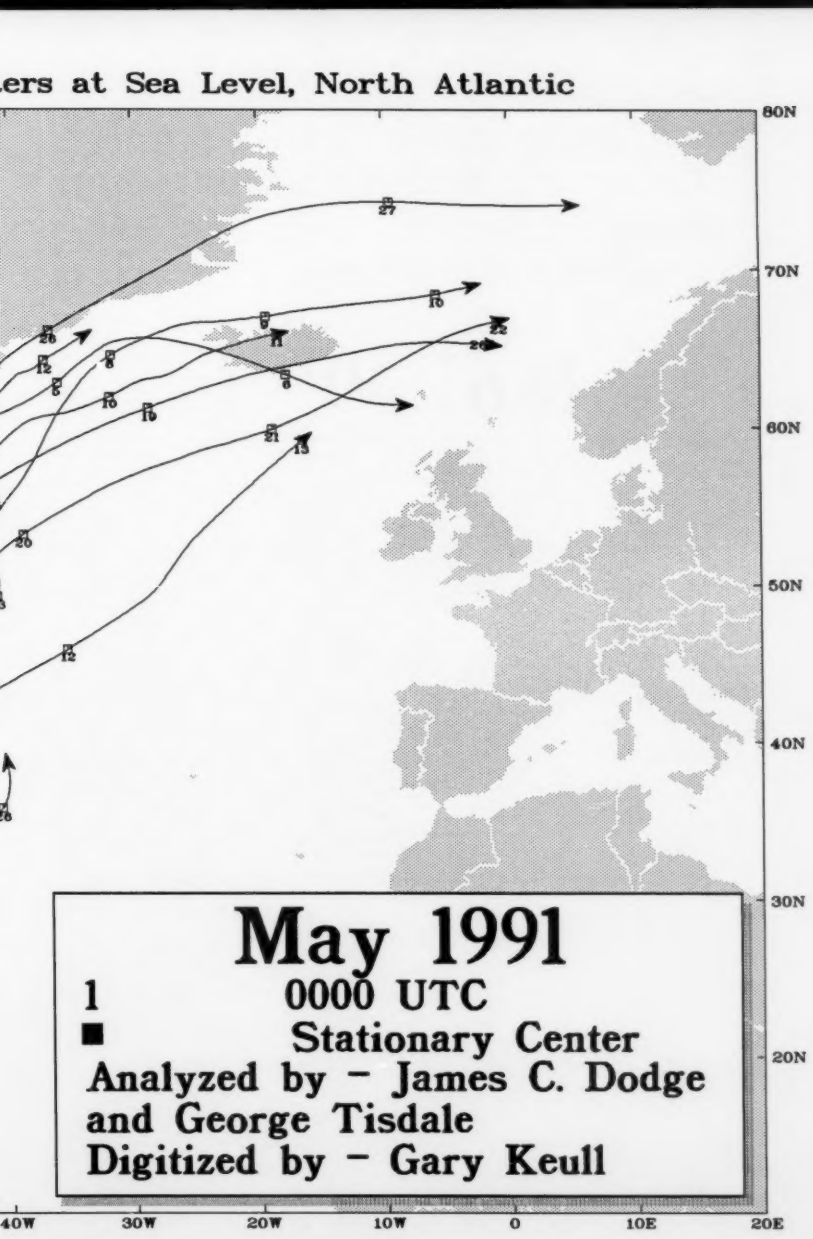
These Charts were Provided by John Kopman and Vernon Kousky of the Climate Analysis Center from the *Climate Diagnostics Bulletin*.

Principal Tracks of Cyclone Cent

enters at Sea Level, North Atlantic

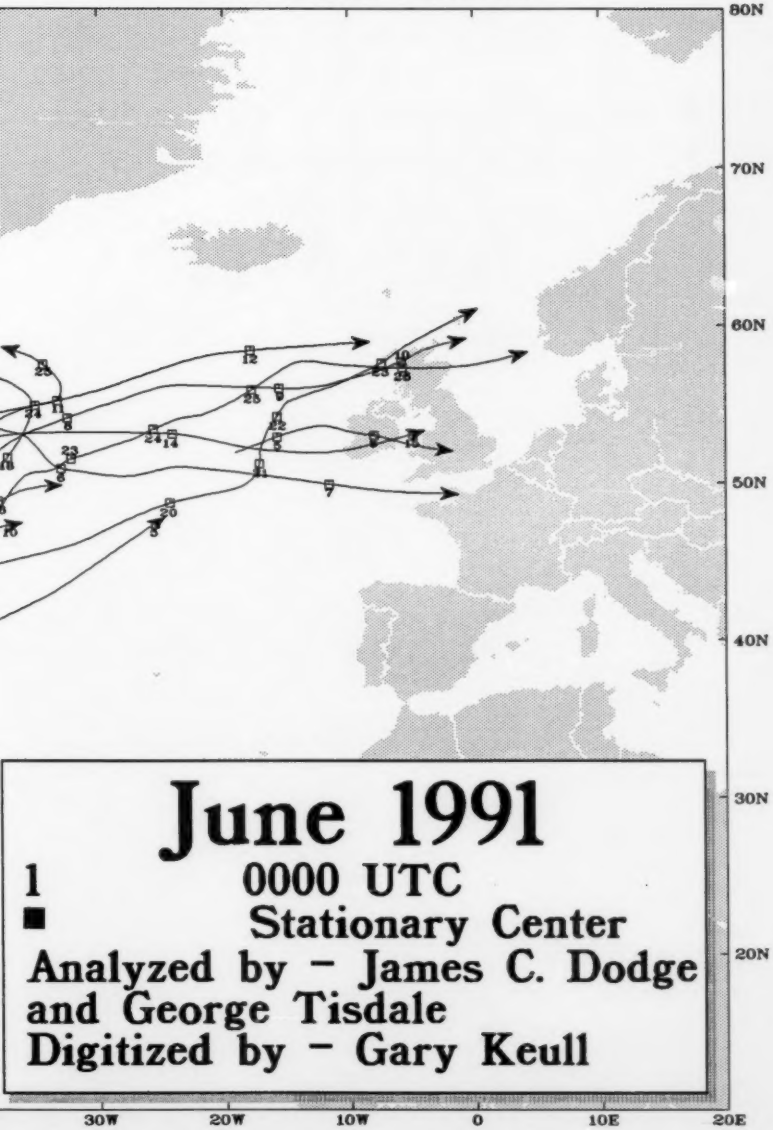


Principal Tracks of Cyclone Center
90W
80W
70W
60W
50W
40W


ers at Sea Level, North Atlantic
80N
70N
60N
50N
40N
30N
20N
40W
30W
20W
10W
0
10E
20E
May 1991
1
0000 UTC
Stationary Center
Analyzed by - James C. Dodge
and George Tisdale
Digitized by - Gary Keull

Principal Tracks of Cyclone Centers a

rs at Sea Level, North Atlantic



June 1991

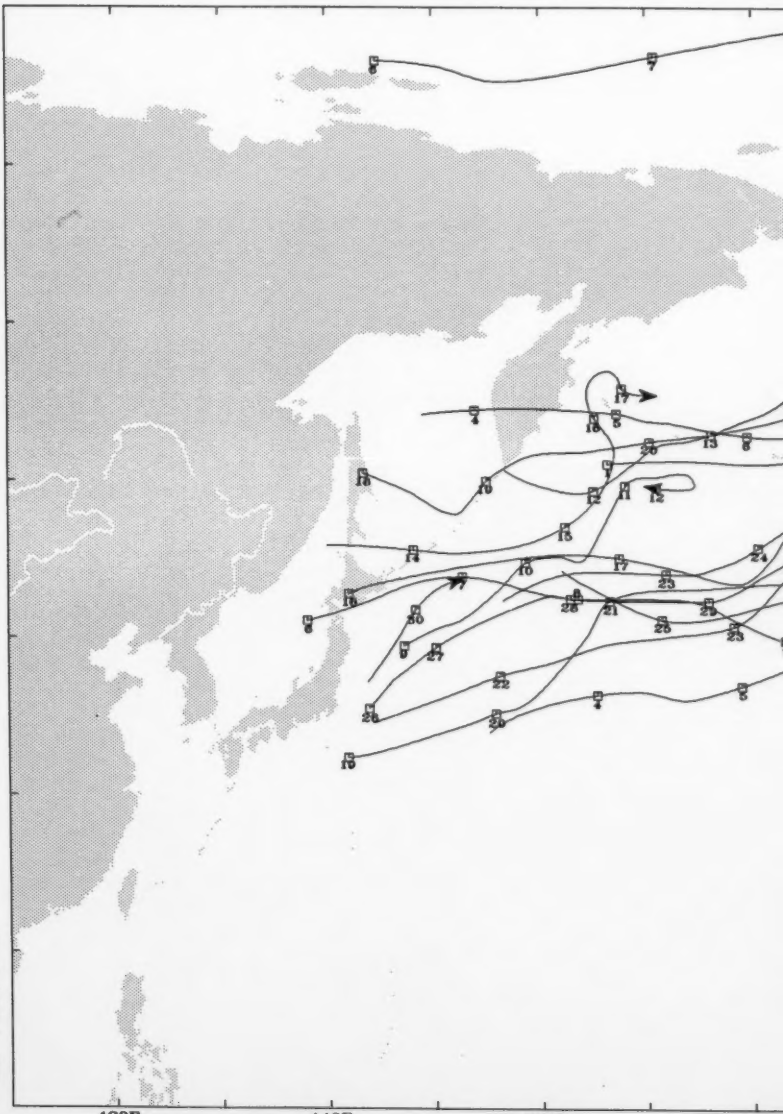
1 0000 UTC

■ Stationary Center

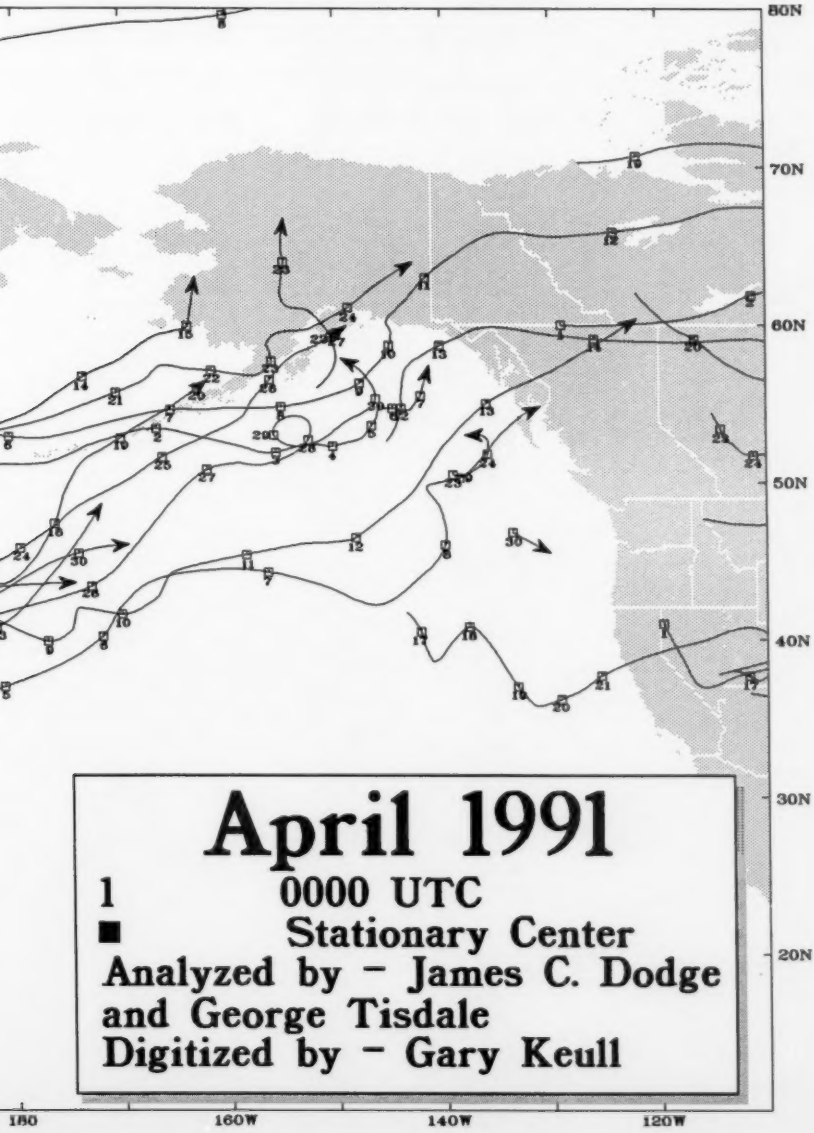
Analyzed by - James C. Dodge and George Tisdale

Digitized by - Gary Keull

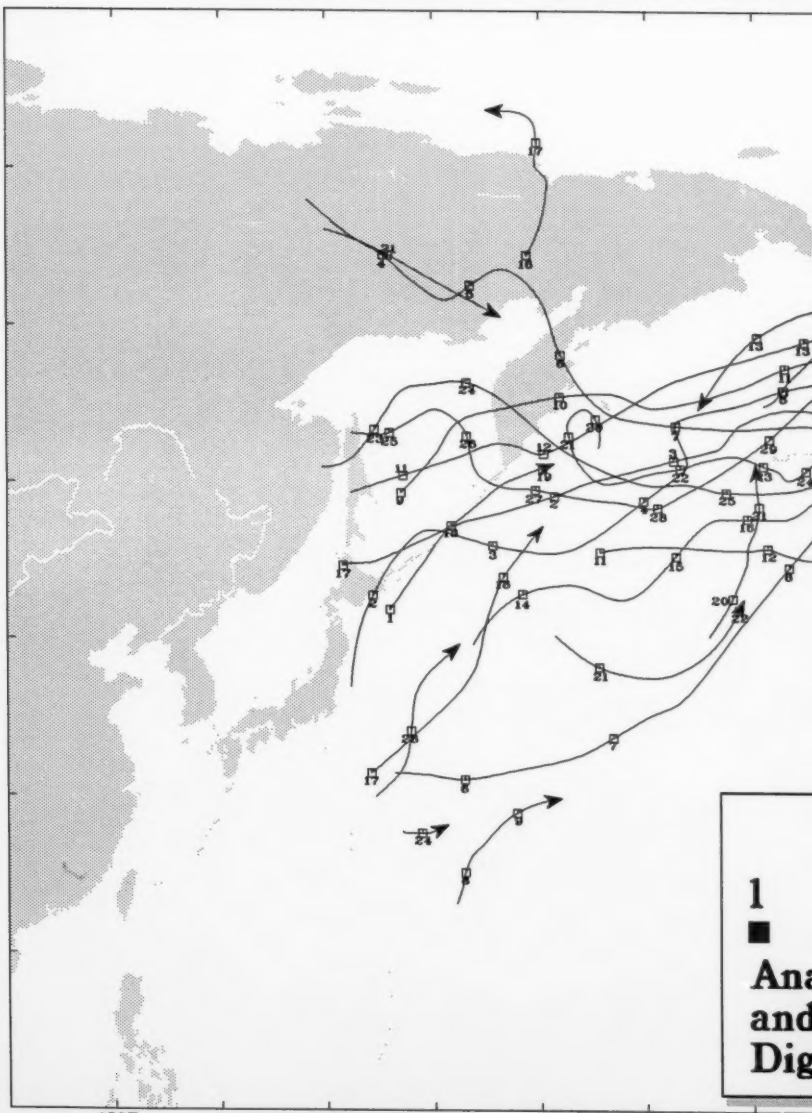
Principal Tracks of Cyclone Center



ters at Sea Level, North Pacific

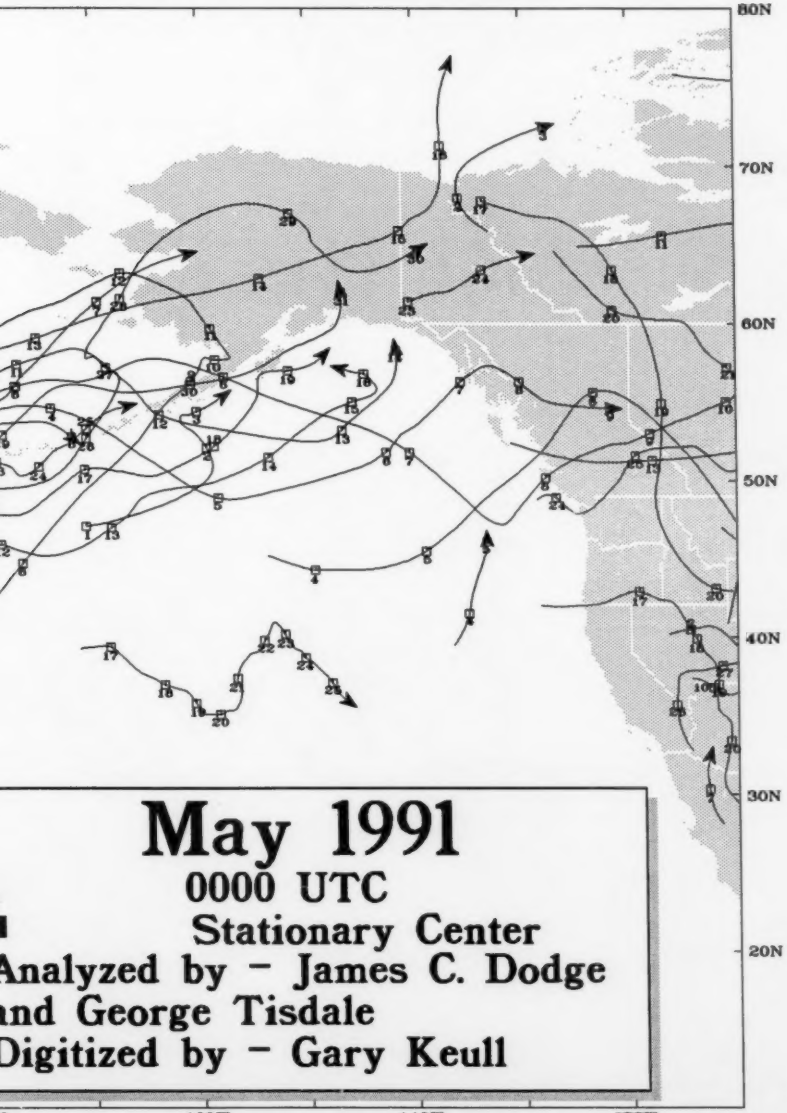


Principal Tracks of Cyclone Centers



1
■
Ana
and
Dig

ers at Sea Level, North Pacific



May 1991

0000 UTC

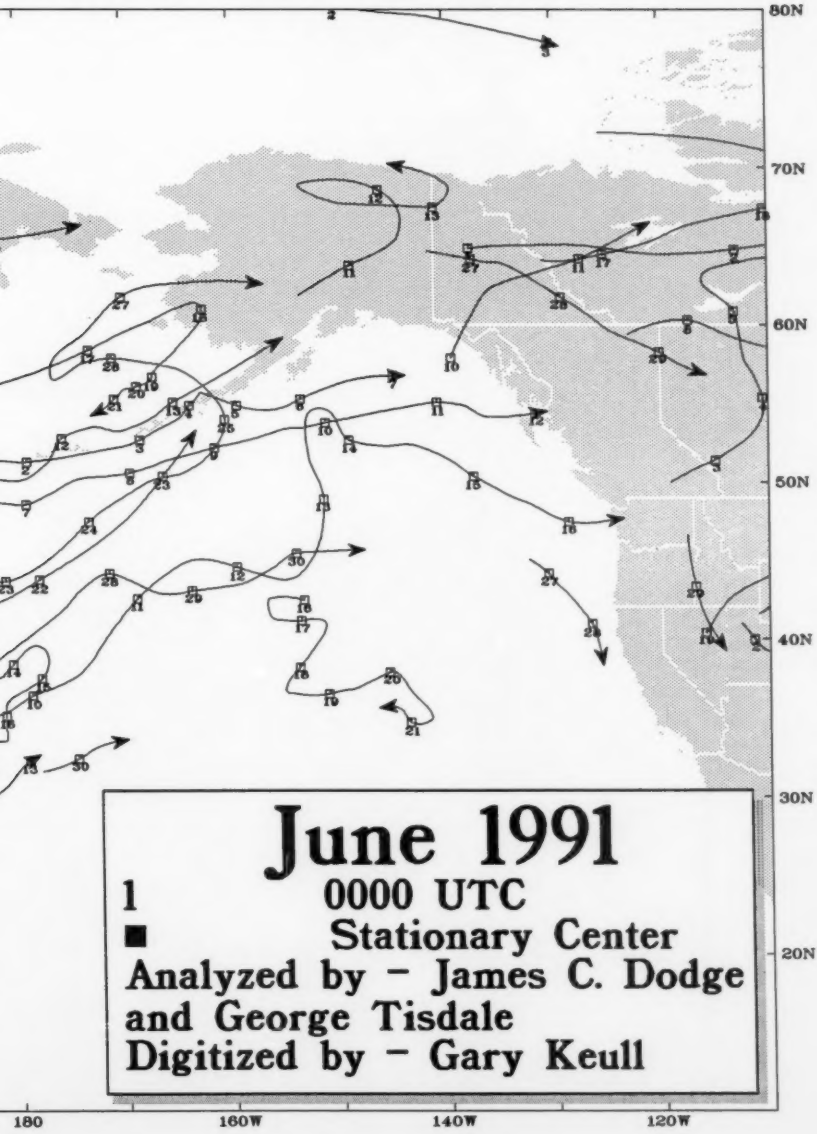
Stationary Center

Analyzed by – James C. Dodge
and George Tisdale

Digitized by – Gary Keull

Principal Tracks of Cyclone Cente

ters at Sea Level, North Pacific



April, May and June 1991

VESSEL	SHIP CALL	DATE	POSITION LAT. deg.	LONG. deg.	TIME GMT	WIND DIR. 10 deg.		SPEED kts.	VSBY		PRES WX. code	PRESS-URE mb	TEMP °C. Air	TEMP °C. Sea	SEA WAVES PD sec	SEA WAVES HGT ft.	SWELL DIR	SWELL WAVES PD sec	SWELL WAVES HGT. ft.
PACIFIC APR.																			
LNG AQUARIUS	WSKJ	1	24.5 N	123.6 E	00	02	M	42	5	NM		1020.0	16.0	23.9	8	19.5			
LNG AQUARIUS	WSKJ	1	25.5 N	124.6 E	06	01	M	42	10	NM	25	1020.0	16.0	22.8	9	19.5			
ALLIGATOR JOY	3EDD8	1	50.3 N	136.5 W	18	20	M	44	5	NM	80	1007.0	6.0	8.0	7	24.5	21	6	26
HANEI SKY	3EZM3	1	46.5 N	175.8 W	18	27	M	46	2	NM		0988.5	3.0	4.0	12	19.5	27	12	19.5
MARIE MAERSK	OULL2	1	44.2 N	176.9 W	18	28	M	45	2	NM		1001.0	7.0	8.1	7	23			
NEPTUNE AMBER	S6CY	2	42.2 N	162.2 W	00	21	M	40				1013.5	10.0		8	14.5	21	12	23
HANEI SKY	3EZM3	2	47.1 N	172.3 W	06	29	M	46	5	NM	15	0994.0	3.0	4.0	12	19.5	29	12	19.5
MARIE MAERSK	OULL2	2	44.0 N	170.0 W	06	29	M	43	1	NM	88	1004.3	5.6	8.9	15	23			
MARIE MAERSK	OULL2	2	44.0 N	167.1 W	12	28	M	40	2	NM		1003.3	5.9	9.5	12	19.5			
HANEI SKY	3EZM3	2	47.2 N	168.4 W	18	28	M	46	10	NM	15	0993.0	2.0	4.0	10	16.5	28	12	19.5
MARIE MAERSK	OULL2	2	44.0 N	164.2 W	18	27	M	41	1	NM	84	1001.0	5.0	9.3	11	23			
HANEI SKY	3EZM3	3	47.3 N	166.4 W	00	29	M	51	2	NM	10	0994.0	4.0	6.0	10	16.5	29	12	19.5
MARIE MAERSK	OULL2	3	44.0 N	161.3 W	00	28	M	44	2	NM		0999.0	8.1	9.6	15	32.5			
HANEI SKY	3EZM3	3	47.3 N	164.9 W	06	29	M	46	5	NM	15	0994.0	4.0	4.0	10	16.5	29	12	19.5
SEALAND TACOMA	KGTY	3	56.7 N	150.5 W	06	05	M	47				0972.0	2.2	2.9	6	29.5	11	8	3
HANEI SKY	3EZM3	3	47.4 N	160.6 W	18	28	M	44	10	NM		0992.5	4.0	4.0	10	16.5	28	12	19.5
HANEI SKY	3EZM3	4	47.4 N	158.5 W	00	28	M	44	10	NM		0991.5	4.0	5.0	10	16.5	28	12	19.5
JOVIAN LILY	DZDV	9	46.0 N	161.9 W	18	09	M	50	1	NM	81	1005.0	5.0	9.0	8	18	10	9	19.5
PRESIDENT MADISON	WCIP	11	52.1 N	156.9 W	00	05		50	5	NM	58	0999.9	2.8	2.8	6	19.5	03	7	18
RUBIN OCEAN	DUVV	15	48.4 N	178.6 E	14	15	M	44	2	NM	97	0999.8	4.5	4.4	12	21	16	13	23
NEW DUQUESA	3EBA3	15	51.1 N	163.7 E	17	24	M	48	1	NM		0985.5	1.0	4.0	10	16.5	24	12	19.5
NEW DUQUESA	3EBA3	16	50.9 N	162.0 E	05	24	M	52				0987.5	1.0	3.0	10	16.5	24	12	19.5
ARCTIC TOKYO	5LJT	16	51.9 N	164.0 E	06	25	M	46	5	NM		0986.5	2.0	4.0	4	10	25	8	23
ARCTIC TOKYO	5LJT	16	51.5 N	162.0 E	12	25	M	46	5	NM		0986.5	2.0	3.0	4	10	25	8	23
HANJIN KUNSAN	HOMH	18	45.4 N	179.9 W	00	29	M	41				0996.5	4.0	11.0	8	19.5	30	8	19.5
SEA BELLS	ELCN7	18	48.0 N	176.0 W	06	25	M	42	5	NM	41	0986.0	4.0	5.0	12	23	25	12	23
EDEN	ELKK3	18	39.0 N	146.1 E	06	20	M	48	.5	NM	58	0993.0	17.0	15.0	8	11.5	20	12	19.5
FLORIDA RAINBOW	ELLW3	18	49.2 N	178.2 W	12	29	M	50	1	NM	51	0991.5	4.0	4.0	3	18	28	6	19.5
NEW DUQUESA	3EBA3	19	43.9 N	148.2 E	05	28	M	47	5	NM	02	0996.5	3.0	3.0	7	16.5	28	9	19.5
PRESIDENT EISENHOWER	KRJG	24	44.3 N	176.3 W	12	28	M	45	5	NM		0991.0	8.0	8.4	6	16.5	29	10	29.5
MITLA	3EOU8	25	37.8 N	179.4 E	18	27	M	44	2	NM	18	1015.0	7.0		6	14.5	27	7	19.5
ASPEN	KACN	29	56.0 N	148.1 W	12	22		40	10	NM		0995.7	1.7	4.4	3	6.5	22	5	19.5
PACIFIC EMERALD	DUPG	30	42.5 N	150.4 E	00	13	M	50	.5	NM		0989.0	7.0	4.0	10	23	13	9	23
BAY BRIDGE	ELES7	30	39.7 N	144.7 E	12	31	M	40				0993.0	9.0	12.0	18	26	28	18	26
METTE MAERSK	OXKT2	30	46.9 N	178.4 W	12	34	M	44	10	NM		1011.5	3.4	5.1	6	19.5			
ATLANTIC APR.																			
MATHILDE MAERSK	OUUU2	6	48.9 N	23.1 W	12	29	M	40	5	NM	16	1008.0	11.0	10.1	6	24.5	29	8	24.5
LINDOE MAERSK	OWEQ2	6	55.4 N	24.5 W	12	32		40	1	NM	80	0980.0	10.4		4	19.5	18	8	19.5
STAR EAGLE	LAWO2	6	47.7 N	14.2 W	18	26		47	5	NM		1013.8	12.5		10	16.5	28	14	19.5
MATHILDE MAERSK	OUUU2	15	48.5 N	40.4 W	12	22	M	50	5	NM		1015.0	7.0	11.0	15	49	23	15	49
MARGARET LYKES	KRJL	17	38.9 N	41.5 W	06	30		53	2	NM	81	1008.0	13.3	13.0	8	21	30	10	21
MARGARET LYKES	KRJL	18	38.9 N	49.2 W	06	28		47	5	NM	25	1010.0	15.2	14.0	5	18	27	6	21
PACIFIC MAY																			
SAN MATEO VICTORY	DZPT	1	38.5 N	170.9 W	00	30	M	40	5	NM	07	1014.0	12.5	14.0	7	19.5	27	12	19.5
SEALAND MARINER	KGJF	1	43.1 N	153.6 E	00	24	M	44	5	NM	15		4.4	4.0	4	8	24	8	21
SEALAND LIBERATOR	KHRP	1	38.3 N	171.1 W	00	29	M	41	10	NM		1017.0	11.0		7	14.5	27	10	24.5
METTE MAERSK	OXKT2	1	46.2 N	172.4 W	00	31	M	48	5	NM		1002.1	8.2	6.4	10	32.5			
METTE MAERSK	OXKT2	1	46.2 N	169.5 W	06	32	M	42	5	NM		0997.5	6.0	6.7	7	32.5			
NOAA SHIP MILLER FREEMAN	WTDM	9	56.1 N	156.6 W	11	11	M	40	50	YD		0978.5	4.6	4.0	3	8	12	3	19.5
EVER GOODS	BKHZ	15	43.9 N	177.3 E	18	25	M	47	2	NM	80	0998.0	6.0		10	24.5	25	10	32.5
ASTRO COACH	ELJY2	31	45.1 N	158.5 E	06	02	M	43	1	NM		0996.5	6.0	4.5	12	18	03	14	19.5
ATLANTIC MAY																			
EXPORT FREEDOM	WCJS	4	36.5 N	64.5 W	16	29		40	5	NM	03	1011.0	17.8	23.3	6	11.5	29	8	19.5
USNS BARTLETT(T-AGOR 13)	NBAD	21	59.0 N	12.6 W	12	27	M	50	5	NM	01	1022.6	8.9	8.3	8	14.5	27	12	32.5
PACIFIC JUNE																			
PRINCE OF TOKYO 2	3EUU6	5	50.1 N	169.3 E	12	07	M	44	1	NM	41	0997.8	5.0	0.0	14	23	07	14	19.5
PRINCE OF TOKYO 2	3EUU6	6	49.4 N	165.5 E	00	01	M	50	1	NM		0991.0	3.5		16	26	01	18	29.5
SEA BELLS	ELCN7	15	48.1 N	140.8 W	00	30	M	41	5	NM	41	1012.0	9.0	10.0	12	23	30	12	23
SEALAND KODIAK	KGTZ	23	52.8 N	153.8 W	18	17		40	2	NM	63	1008.4	10.0	6.5	8	11.5	22	12	19.5
ATLANTIC JUNE																			
NONE																			

April, May and June 1991

Ship Name	Radio	Mail
1ST LT ALEX BONNYMAN	20	
1ST LT JACK LUMMIS	7	
2ND LT. JOHN P. BOBO	36	
A.S.L. CYGNUS[	76	48
ACE ACCORD	37	
ACONCAGVD	24	27
ACT 10	138	
ACT 11	43	
ACT 111	77	
ACT 12	31	
ACT 6	80	
ACT 7	196	
ACT I	182	
ADABELLE LYKES	59	172
ADDIRIYAH	26	
ADMIRALTY BAY	16	34
ADRIAN MAERSK	11	
ADRIANE-E	9	
ADVANTAGE	6	
AGENT	10	
AIDE	39	116
AINO	63	123
AL AHMADIAH	33	32
ALASKA RAINBOW	55	83
ALBERT MAERSK	18	42
ALDEN W. CLAUSEN	30	74
ALEMANIA EXPRESS	73	
ALEVATTYAH		5
ALISON LYKES	29	58
ALLIGATOR FORTUNE	38	
ALLIGATOR EXCELLENCE	59	
ALLIGATOR PRIDE	43	61
ALLIGATOR LIBERTY	41	
ALLIGATOR JOY	36	5
ALLIGATOR HOPE	39	145
ALLIGATOR TRIUMPH	71	
ALMERIA LYKES	34	69
ALPHA HELIX	156	155
ALTAMONTE	14	15
ALVA MAERSK	16	
AMBASSADOR	53	
AMBASSADOR BRIDGE	41	
AMERICA EXPRESS	64	
AMERICAN CORMORANT	11	
AMERICAN CONDOR	54	73
AMERICAN EAGLE	31	
AMERICAN FALCON	42	39
AMERICAN KESTREL	4	
AMERICAN REPUBLIC	27	28
AMERICAN TRADER	41	13
AMERICANA	30	54
AMERIGO VESPUCCI	12	59
ANDERS MAERSK	60	129
ANGLO TURQUOISE	9	
ANNA MAERSK	50	65
ANTHONY RAINBOW	26	58
ARCO ALASKA	33	
ARCO ANCHORAGE	22	27
ARCO CALIFORNIA	1	35
ARCO FAIRBANKS	34	16
ARCO INDEPENDENCE	32	36
ARCO JUNEAU	35	16
ARCO PRUDHOE BAY	12	14
ARCO SAG RIVER	20	13
ARCO TEXAS	9	32
ARCTIC DISCOVERER	8	
ARCTIC OCEAN	6	38
ARCTIC TOKYO	57	100
ARGONAUT	53	80
ARMCO	105	121
ARNOLD MAERSK	21	22
AROSIA	64	49
ARTHUR M. ANDERSON	58	66
ARTHUR MAERSK	25	95
ASHLEY LYKES	34	21
ASPEN	15	60
ASTRO COACH	54	47
ASTRO JYOJIN	65	77
ASTRO VENUS	1	
ATIGUN PASS	7	87
ATLANTIC CONVEYOR	86	
ATLANTIC COMPASS	65	
ATLANTIC CARTIER	43	
ATLANTIC OCEAN	73	102
ATLANTIS II	54	
ATLAS HIGHWAY	47	30
AUSTRAL LIGHTNING	18	
AUSTRAL RAINBOW	4	3
AXEL MAERSK	70	115
B.T. ALASKA	69	131
B.T. SAN DIEGO	34	117
BAAB ULLAH	22	
BACTAZAR	31	53
BALTIMORE TRADER	4	12
BANNER		58
BAR' ZAN	47	39
BAY BRIDGE	101	134
BEATE OLDENDORFF	1	
BEBEDOURO	50	
BEER SHEVA	1	
BELGIAN SENATOR	36	
BIBI	147	
BLUE HAWK	70	
BOHOL SAMPAGUITA	20	87
BONN EXPRESS	66	
BRIGIT MAERSK	1	
BRILLIANCY		85
BRILLIANT ACE	72	
BROOKLYN BRIDGE	27	
BROOKS RANGE	21	
BUNGA KANTAN	9	
BUNGA KENANGA	66	
BURNS HARBOR	337	308
CALCITE II	202	215
CALGA	59	
CALIFORNIA	40	
CALIFORNIA HERMES	37	24
CAPE ALAVA	1	26
CAPE ALEXANDER	22	52
CAPE ANN	15	
CAPE ARCHWAY	3	
CAPE AVINOF	1	
CAPE BLANCO	34	60
CAPE BON	6	
CAPE BORDA	15	58
CAPE BOVER	55	131
CAPE BRETON	7	99
CAPE CANSO	38	
CAPE CATAWBA	1	
CAPE CATOCHE	2	
CAPE CLEAR	13	
CAPE COD	5	
CAPE DECISION	17	96
CAPE DIAMOND	1	
CAPE DOUGLAS	2	64
CAPE EDMONT	1	18
CAPE FLATTERY		30
CAPE GIBSON	2	108
CAPE GIRARDEAU	85	149
CAPE HENRY	49	
CAPE HORN		8
CAPE INSCRIPTION	14	98
CAPE ISABEL	12	
CAPE JOHNSON	35	153
CAPE JUBY	48	50
CAPE LAMBERT	21	6
CAPE LOBOS	29	
CAPE MENDOCINO	24	90
CAPE MOHICAN	6	
CAPE NOME	10	
CARIBAN	21	
CARIBE 1	3	53
CARLA A. HILLS	16	109
CARMAN	24	
CARMEL	25	120
CAROLINA	11	
CARTAGENA	90	138
CASON J. CALLAWAY	211	233
CELEBRATION	17	
CENTURY HIGHWAY #2	214	62
CENTURY HIGHWAY NO. 5	199	56
CGM ILE DE FRANCE	89	68
CGM LORRAINE	31	
CGM PASTEUR	7	
CGM PROVENCE	88	
CHABLIS	43	59
CHACO	14	
CHALLENGER	32	
CHARLES E. WILSON	216	194
CHARLES M. BEEGHLEY	9	
CHARLOTTE LYKES	68	157
CHELSEA	2	
CHEMICAL PIONEER	6	90
CHERRY VALLEY	9	
CHESAPEAKE TRADER	13	
CHESNUT HILL	12	
CHEVRON ANTWERP	2	
CHEVRON ARIZONA	50	106
CHEVRON BURNABY	8	133
CHEVRON CALIFORNIA	101	105
CHEVRON COLORADO	22	33
CHEVRON EDINBURGH	27	
CHEVRON HORIZON		90
CHEVRON LOUISIANA	59	51
CHEVRON METEOR	6	107
CHEVRON MISSISSIPPI	13	55
CHEVRON NAGASAKI	2	150
CHEVRON OREGON	43	59
CHEVRON PACIFIC	54	89
CHEVRON SKY		128
CHEVRON STAR		63
CHEVRON SUN		160
CHICKASAW	21	
CHINA CONTAINER	112	
CHIQUITA BOCAS	109	
CHOAPA	8	
CLARENCE	166	
CLEMENT	43	
CLEMENTINA	22	
CLEVELAND	26	
COAST RANGE	27	37
COASTAL CORPUS CHRISTI	17	19
COASTAL MANATEE	13	21
COLIMA	26	123
COLUMBIA STAR	107	100
COLUMBINE	23	
COLUMBUS AUSTRALIA	144	
COLUMBUS AMERICA	160	
COLUMBUS CANADA	166	
COLUMBUS ISELIN		69
COLUMBUS LOUISANA	158	
COLUMBUS NEW ZEALAND	73	
COLUMBUS ONTARIO	186	
COLUMBUS OLIVOS	18	30
COLUMBUS OHIO	12	11
COLUMBUS QUEENSLAND	48	
COLUMBUS VIRGINIA	189	
COLUMBUS VICTORIA	176	
COLUMBUS WELLINGTON	209	
COMPANION EXPRESS	47	
CONCERT EXPRESS	59	
CONSENSUS SEA	25	
CONTIENTAL WING	103	78
CONTSHIP SPAIN		55
CORAH ANN	49	53
CORMORANT ARROW	3	
CORNHUSKER STATE	47	
CORNUCOPIA	29	44
CORONADO	21	
CORWITH CRAMER	49	64
COURIER	30	15
COURTNEY BURTON	54	35
CPL. LOUIS J. HAUGE JR	69	
CRISPEN OGLEBAY	22	20
CRISTOFORO COLOMBO	27	29
CSS HUDSON	179	
CYPRESS PASS	27	
D. L. BOWER		66
DAN MOORE	4	21
DAVID PACKARD		60
DEL MONTE HARVESTER	3	15
DEL MONTE	32	
DELAWARE TRADER	25	52
DEPPE AMERICA	57	
DOLE ECUADOR		119
DON JORGE	4	
DONAIRE		253
DUSSELDORF EXPRESS	68	
EASTERN GLORY	27	
EASTERN VENTURE	46	117
EDEN	30	98
EDGAR B. SPEER	266	232
EDWARD L. RYERSON	95	74
EDWIN H. GOTT	250	172
EDYTH.L.	71	160
ELBE MARU	57	
ELIZABETH LYKES	2	
ELSAM FYN	52	78
E. M. FORD	27	27
EMERALD SEA	165	220
ENDEAVOR	89	61

Ship Name	Radio	Mail
ENSOR	50	69
EQUALITY STATE	58	40
ESSO PUERTO RICO	14	34
ETERNITY	38	65
EVER GAINING	6	9
EVER GALLANT	10	
EVER GARLAND	1	
EVER GENIUS	3	
EVER GENTLE	3	
EVER GIANT	7	
EVER GIFTED	5	16
EVER GIVEN	4	
EVER GLOBE	20	
EVER GLOWING	10	
EVER GOING	4	
EVER GOODS	6	65
EVER GOVERN	6	
EVER GRAND	6	7
EVER GROUP	9	
EVER GROWTH	5	10
EVER GUARD	27	34
EVER GUIDE		7
EVER LEVEL	10	17
EVER LINKING	6	
EVER LOADING	1	
EVER LYRIC	16	14
EVER VITAL	10	141
EXPORT FREEDOM	33	78
EXPORT PATRIOT	46	1
EXXON BATON ROUGE	6	7
EXXON BENICIA	17	22
EXXON CHARLESTON	26	22
EXXON LONG BEACH	6	
EXXON NEW ORLEANS	15	10
EXXON PHILADELPHIA	27	
EXXON WILMINGTON	17	24
FAIRLIFT	17	
FAIRWIND	1	
FALCON CHAMPION		12
FALCON LEADER	57	92
FALSTAFF	16	
FARNELLA	200	
FAUST	38	29
FERNCROFT	182	216
FESTIVALE	6	
FETISH	119	99
FLICKERTAIL STATE	67	
FLORIDA RAINBOW	23	83
FORTALEZA	58	108
FRANCES.L.	64	130
FRANCIS SINCERE NO. 6	56	
FRED R WHITE JR	9	67
FRED R. WHITE JR	9	
FROTASIRIUS	2	
FUJI	32	76
GALVESTON BAY	62	73
GEMINI	40	55
GENEVIEVE LYKES	16	44
GEORGE A. SLOAN	73	55
GEORGE A. STINSON	145	107
GEORGE WASHINGTON BRID	173	27
GERMAN SENATOR	41	
GERONIMO	9	16
GLACIER BAY	52	113
GLOBAL FAME	18	
GOLDEN ENDEAVOR	17	36
GOLDEN GATE	1	
GOLDEN GATE BRIDGE	193	54
GOLDEN MONARCH	23	
GOLDEN TOPAZ	3	4
GOPHER STATE	41	
GRAIGLAS	106	
GREAT LAND	165	287
GREAT RIVER	12	
GREEN BAY	55	99
GREEN ELLIOTT		27
GREEN HARBOUR	44	
GREEN ISLAND	7	
GREEN KOBE	12	33
GREEN LAKE	34	
GREEN MAYA	70	60
GREEN RIDGE	34	
GREEN SAIKAI	22	100
GREEN SUMA	28	136
GREEN VALLEY	30	
GREEN WAVE	62	141
GUANAJUATO	43	105
GUAYAMA	9	12
GULF SENTRY	25	22
GULF SPEED	8	
GULF SPIRIT	36	
GYPSUM BARON	12	
GYRE	5	

Ship Name	Radio	Mail
HAKONE MARU	76	
HANEI SKY	17	28
HANEI SUN	33	7
HANJIN BUSAN	14	12
HANJIN CHEJU	7	3
HANJIN CHUNGMU	10	
HANJIN HONG KONG	6	8
HANJIN KEELUNG	16	15
HANJIN KOBE	25	
HANJIN KUNSAN	30	26
HANJIN KWANG YANG	23	29
HANJIN LE HAVRE	7	7
HANJIN LONG BEACH	11	
HANJIN MASAN	4	
HANJIN NEW YORK	20	
HANJIN POHANG	36	20
HANJIN SAVANNAH	18	17
HANJIN SEATTLE	9	10
HANJIN SEOUL	33	21
HANJIN TONGHAE	9	5
HANJIN YOKOHAMA	10	
HANNOVERLAND	28	
HANSA LUBECK	84	
HARMAC DAWN	22	
HAWAIIAN RAINBOW	27	75
HEIDELBERG EXPRESS	57	
HENRY HUDSON BRIDGE	179	
HERACLITUS	9	53
HERBERT C. JACKSON	58	48
HERMENIA	46	27
HESIOD	1	
HIBISCUS	9	
HIRA II	51	48
HOEGH CAIRN	8	
HOEGH CLIPPER	4	
HOEGH DENE	14	
HOEGH DUKE	50	
HOEGH DYKE	12	
HOEGH MASCOT	9	50
HOEGH MIRANDA	46	27
HOLIDAY	16	25
HONOLULU	50	
HOWELL LYKES	32	90
HRELJIN	1	
HUAL ANGELITA	15	
HUMACAO	38	155
HUMBER ARM	5	32
HYUNDAI #201	10	
HYUNDAI CHALLENGER	12	
HYUNDAI COMMANDER	29	
HYUNDAI CONTINENTAL	43	
HYUNDAI CON SIX	1	
HYUNDAI EXPLORER	18	
HYUNDAI INNOVATOR	15	
HYUNDAI NO 102	7	
HYUNDAI PIONEER	10	
INCOTRANS PACIFIC	25	
INDEPENDENT SPIRIT	91	
INDIAN OCEAN	11	8
INFANTA	141	
INGER	4	
ISLA PUNA	2	
ISLAND PRINCESS	61	
IST LT BALDOMERO LOPEZ	21	
ITAPE	15	
ITB BALTIMORE	64	143
ITB CHARLESTON	37	120
ITB NEW YORK	6	1
J.A.W. INGLEHART	53	55
ITB PHILADELPHIA	65	160
J.L. MAUTHE	107	113
JACKSONVILLE	43	33
JADRAN EXPRESS	8	
JALISCO	24	37
JAMES LYKES	1	
JAPAN ALLIANCE	92	94
JAPAN APOLLO	81	101
JAPAN CARRYALL	10	
JAPAN RAINBOW #2	19	27
JEAN LYKES	47	12
JO BIRK	25	
JO CLIPPER	170	
JO CYPRESS	54	
JO LONN	84	
JO OAK	81	
JOHN A. MCCONE		145
JOHN G. MUNSON	139	32
JOHN G.MUNSON		47
JOHN LYKES	54	4
JOHN YOUNG		73
JOSEPH H. FRANTZ	167	201
JOSEPH LYKES	41	35
JOVIAN LILY	63	256
JOVIAN LUZON	72	55

Ship Name	Radio	Mail
JULIUS HAMMER	79	75
JUPITER	1	69
K. TOPIC	5	3
KAIMOKU	46	79
KAINULA	40	180
KALIDAS	1	
KATHLEEN PEARCY	68	77
KAUAI	69	154
KAYE E. BARKER	137	142
KEBAN		21
KEE LUNG	3	61
KEISHO MARU	40	
KENAI	35	
KENNETH E. HILL	10	86
KENTUCKY HIGHWAY	11	
KEYSTONE CANYON	75	116
KEYSTONER	30	106
KISO	99	
KITTANING	10	
KOKUA	79	113
KOLN ATLANTIC	102	
KOPER EXPRESS	5	
KUROBE	6	
LAKE	47	98
LASH ATLANTICO	10	
LEE A. TREGURTHA	126	134
LAWRENCE H. GIANELLA	4	5
LESLIE LYKES	1	83
LIBERTY STAR	55	143
LIBERTY SUN	59	115
LIBERTY WAVE	17	
LILAS	28	262
LINDOE MAERSK	42	82
LIRCAY	51	
LNG AQUARIUS	29	5
LNG CAPRICORN	29	29
LNG LEO	57	52
LNG LIBRA	54	44
LNG TAURUS	18	60
LNG VIRGO	5	9
LONDON SENATOR	113	
LOTUS ACE	57	
LOUIS MAERSK	34	27
LOUISE LYKES	12	26
LT. ODYSSEY	59	
LURLINE	37	162
LYRA	44	117
M. P. GRACE	18	
MAASSLOT	135	
MACKINAC BRIDGE	171	33
MAERSK COMMANDER	108	
MAERSK CONSTELLATION	29	107
MAERSK PINE	193	153
MAERSK SUN	16	
MAERSK WIND	84	82
MAGALLANES	2	13
MAGIC	116	37
MAGLEBY MAERSK	22	52
MAGLEBY MHERSK		31
MAINE	4	44
MAJ STEPHEN W PLESS MP	47	86
MAJESTIC MAERSK	20	92
MAJURO	11	23
MALLORY LYKES	54	136
MANHATTAN BRIDGE	125	
MANUKAI	57	186
MANULANI	55	164
MARATHA MAJESTY	61	73
MARATHIS PROVIDENCE	14	19
MARCHEN MAERSK	20	102
MAREN MAERSK	21	28
MARGARET LYKES	39	91
MARGRETHE MAERSK	53	41
MARIA TOPIC	5	
MARIE MAERSK	23	90
MARIF	28	25
MARINE RELIANCE	57	
MARIT MAERSK	18	77
MARJORIE LYKES		7
MARLIN		80
MASON LYKES	30	75
MATHILDE MAERSK	9	86
MATSONIA	59	188
MAUI	44	192
MAURICE EWING	104	
MAYAGUEZ	2	
MCKINNEY MAERSK	40	119
MEDALLION	48	31
MEDUSA CHALLENGER	107	85
MERCANDIAN SUN II	78	
MERCANDIAN CONTINENT	34	19
MERCURY ACE	40	
MERIDA	76	139
MERKUR AMERICA	23	

Ship Name	Radio	Mail
MERKUR PORTUGAL	2	
METTE MAERSK	55	127
MICHIGAN HIGHWAY	31	
MICRONESIAN INDEPENDEN	7	
MICRONESIAN COMMERCE	39	
MIDDLETOWN	73	37
MINDORO SAMPAGUITA	16	
MINERAL OSPREY	5	
MINERVA	8	
MING COMFORT	2	
MING LONGEVITY	18	20
MING OCEAN	5	
MING PLEASURE	6	
MING PROSPERITY	11	
MISSION BUENAVENTURA	26	65
MITLA	33	51
MOANA PACIFIC	75	
MOKU PAHU	64	138
MONA WAVE	83	1
MONTERREY	99	
MORELLO	17	
MORELOS	132	230
MORMACSKY	40	
MORMACSTAR	42	
MORMACSUS	58	9
MSC CHIARA	48	52
MSC SABRINA	33	51
MV CAPE DIAMOND	11	
MYRON C. TAYLOR	83	92
NACIONAL SANTOS	4	
NANCY LYKES	38	
NANA	55	
NATIONAL DIGNITY	32	124
NATIONAL HONOR	30	62
NATIONAL PRIDE	32	44
NAVIOS UNIQUE	46	
NCC ARAR	6	8
NECHES	5	
NEDLLOYD BAHRAIN	36	
NEDLLOYD BARCELONA	116	
NEDLLOYD BANGKOK	75	
NEDLLOYD BALTIMORE	103	
NEDLLOYD HOLLAND	45	144
NEDLLOYD HUDSON	71	149
NEDLLOYD KIMBERLEY	3	
NEDLLOYD KINGSTON	3	
NEDLLOYD MANILA	78	
NEDLLOYD ROUEN	158	
NEDLLOYD ROTTERDAM	83	
NEDLLOYD VAN CLOON	90	
NEPTUNE ACE	23	
NEPTUNE AMBER	89	267
NEPTUNE CORAL	23	11
NEPTUNE CRYSTAL	50	128
NEPTUNE DIAMOND	104	
NEPTUNE GARNET	27	
NEPTUNE JADE	45	
NEPTUNE PEARL	109	199
NEW DUQUESA	18	65
NEW HORIZON	57	78
NEWARK BAY	53	145
NOAA DAVID STARR JORDA	13	19
NOAA SHIP CHAPMAN	358	212
NOAA SHIP WHITING	383	421
NOAA SHIP T. CROMWELL	104	181
NOAA SHIP SURVEYOR	113	
NOAA SHIP RAINIER	231	
NOAA SHIP OREGON II	406	94
NOAA SHIP MT MITCHELL	428	502
NOAA SHIP MILLER FREEM	152	118
NOAA SHIP MCARTHUR	33	
NOAA SHIP M. BALDRIDGE	144	395
NOAA SHIP HECK 591	1	
NOAA SHIP FERREL	44	36
NOAA SHIP DISCOVERER O	464	475
NOAA SHIP DELAWARE II	371	
NOBEL STAR	6	103
NORTHERN LIGHT	9	57
NOSAC EXPLORER	13	34
NOSAC EXPRESS	16	63
NOSAC RANGER	44	75
NOSAC TAKAYAMA	130	
NOVA EUROPA	15	23
NUEVO SAN JUAN	35	163
NURNBERG ATLANTIC	94	
OAXACA	96	
OCEAN ASPIRATION	20	66
OCEAN BRIDGE	13	
OCEAN CHEER	28	32
OCEAN COMMANDER #1	20	
OCEAN CONQUEROR	22	131
OCEAN HIGHWAY	42	
OCEAN ISLAND	15	
OCEAN LILY	34	34
OCEAN MASTER	11	
OCEAN SEL	2	15
OCEAN SPIRIT	2	
OLEANDER	105	92
OLGA TOPIC	3	49
OGLEBAY NORTON	73	81
OMI CHARGER	7	31
OMI MISSOURI	21	59
OMI WABASH	34	23
OOCL CHARGER	84	
OOCL DOMINANCE	2	
OOCL EDUCATOR	54	31
OOCL EXECUTIVE	68	31
OOCL FAIR	18	50
OOCL FAITH	30	24
OOCL FORTUNE	15	
OOCL FRIENDSHIP	35	63
ORANGE BLOSSOM	60	
ORANGE STAR	34	48
ORCHID	26	126
ORCHID #2	1	
OREGON RAINBOW II	45	
ORIENTAL EXPLORER	17	97
ORIENTAL FREEDOM	106	
ORIENTAL PATRIOT	47	34
ORION HIGHWAY	39	72
OVERSEAS ALICE	6	
OVERSEAS CHICAGO	12	
OVERSEAS HARRIET	24	
OVERSEAS JOYCE	57	22
OVERSEAS JUNEAU		16
OVERSEAS MARILYN	35	102
OVERSEAS NEW YORK	66	
OVERSEAS NEW ORLEANS	20	98
OVERSEAS OHIO		92
OVERSEAS PHILADELPHIA		10
OVERSEAS VIVIAN	3	
OVERSEAS VALDEZ	13	
PACASIA	17	16
PACBARON	20	
PACDUCHESS	62	
PACDUKE	22	11
PACGLORY	33	
PACIFIC EMERALD	18	127
PACIFIC PRINCESS	57	
PACKING	27	
PACMERCHANT	6	
PACNOBLE	24	
PACOCEAN	8	
PACPRINCE	11	
PACPRINCESS	59	
PACQUEEN	26	58
PACSEA	4	
PACSTAR	23	
PACSUN	4	
PACTRADER	13	
PAGA	8	
PAPAGO	88	123
PAPYRUS	12	48
PATRIOT	61	17
PAUL H. TOWNSEND	57	57
PAUL THAYER	59	52
PECOS	10	28
PEGGY DOW	134	
PELANDER	31	99
PENNSYLVANIA TRADER	33	
PERMEKE	79	126
PETER W. ANDERSON	7	
PETROBULK PROGRESS	86	124
PFC DEWAYNE T. WILLIAM	3	
PFC EUGENE A. OBREGON	44	86
PFC JAMES ANDERSON JR	19	43
PFC WILLIAM B. BAUGH	22	27
PHAROS	37	
PHILIP R. CLARKE	115	130
PHILLIPS VENEZUELA		17
PINE FOREST	11	41
POLAR ALASKA	5	158
POLYNESIA	241	238
POMEROL	7	
PONCE	30	104
POTOMAC TRADER	31	55
PRESIDENT PIERCE	2	6
PRESIDENT MONROE	49	97
PRESIDENT MADISON	33	83
PRESIDENT LINCOLN	105	122
PRESIDENT KENNEDY	93	113
PRESIDENT JOHNSON	60	112
PRESIDENT JACKSON	130	137
PRESIDENT HOOVER	72	141
PRESIDENT HARRISON	94	25
PRESIDENT HARDING	45	70
PRESIDENT GRANT	59	128
PRESIDENT F. ROOSEVELT	26	152
PRESIDENT EISENHOWER	122	154
PRESIDENT BUCHANAN	29	
PRESIDENT ARTHUR	22	93
PRESIDENT ADAMS	41	195
PRESIDENT WASHINGTON	171	
PRESIDENT TYLER	91	227
PRESIDENT TRUMAN	93	120
PRESIDENT TAFT	7	
PRESIDENT POLK	109	114
PRESQUE ISLE	91	27
PRIDE	2	17
PRIDE OF TEXAS	11	51
PRIMORJE	4	
PRINCE OF TOKYO	94	191
PRINCE OF TOKYO 2	122	228
PRINCE WILLIAM SOUND	25	
PROSPERO	30	
PUERTO CORTES	6	
PURITAN	37	
PVT HARRY FISHER	7	66
QUALITY OF LIFE	34	
QUEEN ELIZABETH 2	87	
RAINBOW BRIDGE	51	37
RAINBOW HOPE	175	193
RALEIGH BAY	61	95
RANA M	95	
RECIFE	77	
RED ARROW	1	
RESOLUTE	26	47
RICHARD G MATTIESEN	67	
RIO FRIO	86	
RIO NEGRO II	16	
RISING STAR	16	
ROBERT E. LEE	25	
ROGER BLOUGH	50	111
ROGER R. SIMONS	70	
ROSEBANK	88	
ROSETTA	55	
ROSINA TOPIC	26	
ROTTERDAM	32	
ROVER	5	81
ROWANBANK	67	
ROYAL PRINCESS	104	
RUBIN OCEAN	17	26
RUTH LYKES	1	
S.T. CRAPO	203	110
S/L ENDURANCE	39	14
S/S C.W.KITTS		140
SALINAS	20	59
SAM HOUSTON	21	
SAMU	34	69
SAMUEL L. COBB	31	20
SAN MARTIN	37	
SAN MATEO VICTORY	26	101
SANKO LILY	22	
SANKO PIONEER	4	
SANKO PRELUDE	15	79
SANSINENA II	22	1
SANTA ANA	39	
SANTA MARTA	57	
SANTOS	23	
SANWA MARU	8	
SAPAI	5	24
SATURN DIAMOND	21	
SAUDI DIRIYAH	5	
SAVANNAH	97	
SCAN	2	
SCARAB	88	82
SCHACKENBORG		17
SEA BELLS	23	36
SEA BREEZE II	12	14
SEA COMMERCE	161	
SEA FAN	66	126
SEA FORTUNE	19	161
SEA FOX	28	
SEA LIGHT	38	18
SEA LION	253	122
SEA MERCHANT	326	82
SEA TRADE	42	
SEA WOLF	256	289
SEALAND ACHIEVER	152	
SEALAND ANCHORAGE	33	127
SEALAND ATLANTIC	41	74
SEALAND CHALLENGER	50	123
SEALAND CONSUMER	35	98
SEALAND CRUSADER	64	1
SEALAND DEVELOPER	41	
SEALAND DEFENDER	117	108
SEALAND DISCOVERY		3
SEALAND ENTERPRISE	193	240
SEALAND EXPRESS	55	132
SEALAND EXPLORER	84	129
SEALAND EXPEDITION	10	90
SEALAND FREEDOM	17	22

Ship Name	Radio	Mail
SEALAND HAWAII	76	203
SEALAND INDEPENDENCE	53	148
SEALAND INTEGRITY	67	134
SEALAND INNOVATOR	83	190
SEALAND KODIAK	56	92
SEALAND LIBERATOR	53	134
SEALAND MARINER	43	132
SEALAND NAVIGATOR	118	180
SEALAND PATRIOT	63	110
SEALAND PACIFIC	167	67
SEALAND PERFORMANCE	112	112
SEALAND PRODUCER	58	217
SEALAND QUALITY	77	123
SEALAND RELIANCE	89	41
SEALAND SPIRIT	50	195
SEALAND TACOMA	41	168
SEALAND TRADER	135	178
SEALAND VALUE	66	113
SEALAND VOYAGER	111	92
SEAWARD BAY	32	43
SEDCO/BP 471	203	120
SEMINOLE	60	61
SENATOR	6	94
SGT WILLIAM A BUTTON	9	41
SGT. METEJ KOCAK	44	115
SHELDON LYKES	61	103
SHELLY BAY	52	156
SHENAHON	16	13
SHIN BEISHU MARU	85	
SHINKASHU MARU	66	
SHIRAOI MARU	138	27
SHOSHONE SPIRIT	35	
SIERRA MADRE	10	
SILVER CLIPPER	53	20
SILVER HILL	160	135
SITHEA	31	84
SKANDERBORG	54	103
SKAUBORD	174	132
SKAUGRAN	147	85
SOARER CUPID	35	92
SOLAR WING	54	61
SONORA	51	
SOPHIA	36	
SOREN TOUBRO	3	
SOUTHLAND STAR	174	
SPIRIT OF TEXAS	45	17
SPRING BEAR	20	
SPRING BEE	29	27
SPRING DELIGHT	1	
SPRING STORK	33	
SS BUCKEYE	0	0
S.T. CRAPO	152	152
STAR CANADIAN	29	
STAR EAGLE	66	116
STAR EVVIVA	20	6
STAR FLORIDA	61	
STAR FRASER	90	
STAR FUJI	22	
STAR GEIRANGER	17	
STAR GRAN	79	127
STAR GRINDANGER	11	
STAR HONG KONG	161	
STAR MERCHANT	7	28
STAR MERIT	22	67
STAR MINERVA	46	
STAR MUSKETEER	3	
STAR STROENEN	64	111
STAR WILMINGTON	20	
STATE OF MAINE	38	
STELLA LYKES	49	43
STENA TRAILER	63	
STEWART J. CORT	199	214
STONEWALL JACKSON	29	
STUTTGART EXPRESS	62	
SUE LYKES	16	26
SUGAR ISLANDER	27	20
SUNBELT DIXIE	5	92
SUNRISE RUBY	6	115
SUNWARD II	11	
SWAN LAKE	58	
SWIFTNES	15	
T.S.EMPIRE STATE	57	103
TABASCO	41	100
TAI CHUNG	31	23
TAI CORN	2	
TAI SHING	12	
TAMPA	10	5
TAMPA BAY	17	30
TEXACO NEW YORK	15	2
TEXACO WESTCHESTER	48	
TEXAS CITY SEA	43	90
TEXAS TRADER	11	
THOMAS WASHINGTON	126	218
THOMPSON LYKES	23	48
THOMPSON PASS		1
TILLIE LYKES	62	141
TOHZAN	22	15
TOKYO MARU	1	
TOLUCA	154	114
TONCI TOPIC	1	
TONSINA	28	34
TORRENS	13	13
TRANSWORLD BRIDGE	81	36
TRIGGER	36	
TRITON	223	235
TROPIC SUN	11	9
TROPICAL BEAUTY		26
TROPICALE	8	
TULSIDAS	6	
TUMILCO	74	
TYSON LYKES	15	
ULTRAMAR	14	22
ULTRASEA	1	6
UNAMONTE	27	15
UNITED HOPE	1	
UNIVERSE	44	
URTE	209	149
USCGC ACACIA (WLB406)	23	9
USCGC ACTIVE WMEC 618	32	
USCGC ACUSHNET WMEC 16	24	9
USCGC ALERT (WMEC 630)		2
USCGC BASSWOOD (WLB 38	12	
USCGC BEAR (WEMC 901)	22	
USCGC BISCAYNE BAY	19	7
USCGC BOUTWELL WHEC 71	124	
USCGC BRAMBLE (WLB 392	31	
USCGC BUTTONWOOD WLB 3	6	
USCGC CAMPBELL	30	
USCGC CHILULA (WMEC 15	5	
USCGC CITRUS (WMEC 300	69	
USCGC CONFIDENCE WMEC6	22	
USCGC COURAGEOUS	19	
USCGC DEPENDABLE		4
USCGC DURABLE (WMEC 62	15	
USCGC EAGLE (WIX 327)	37	
USCGC ESCAPE (WMEC 6)	82	
USCGC FIREBUSH WLB 393	59	
USCGC FORWARD	7	143
USCGC HAMILTON WHEC 71	11	
USCGC HARRIET LANE	1	
USCGC IRONWOOD (WLB 29	111	120
USCGC LEGARE	1	
USCGC MACKINAW	21	13
USCGC MUNRO	1	
USCGC NORTHLAND WMEC 9	57	18
USCGC PAPAW (WLB 308)	2	
USCGC PLANETREE	3	
USCGC POLAR STAR WAGB	148	
USCGC POLAR SEA WAGB 1	14	14
USCGC RELIANCE WMEC 61	15	
USCGC SEDGE (WLB 402)	21	49
USCGC SPENCER	15	
USCGC STEADFAST WMEC 6	5	
USCGC STORIS (WMEC 38)	28	3
USCGC SUNDEW (WLB 404)	28	44
USCGC SWEETBRIER WLB 4	45	
USCGC TAHOMA	68	
USCGC TAMAROA (WMEC 16	44	
USCGC TAMPA WMEC 902		33
USCGC VALIANT (WMEC 62	17	96
USCGC VIGOROUS WMEC 62	16	
USNA SIOUX	29	
USNS ALGOL	8	
USNS ALTAIR	20	
USNS APACHE (T-ATF 172	62	
USNS BARTLETT(T-AGOR 1	2	225
USNS BELLATRIX	52	20
USNS CAPELLA	16	42
USNS CHAUVENET TAGS 29	18	
USNS COMET	28	24
USNS DE STEIGUER	7	
USNS DENEBOLA	63	71
USNS GUS W. DARNELL	63	30
USNS HENRY J. KAISER		69
USNS JOHN LENTHAL		9
USNS JOSHUA HUMPREYS		11
USNS KAWISHWI	85	40
USNS MERCURY	41	43
USNS METEOR	20	
USNS MISSISSINEWA		21
USNS MOHAWK (T-ATF 170	29	
USNS NARRAGANSETT	28	47
USNS NAVAJO	71	47
USNS PAWCATUCK TAO-108		218
USNS PECOS	16	
USNS POLLUX	4	35
USNS RANGE SENTINEL	1	
USNS REGULUS	87	
USNS RIGEL (T-AF 58)		70
USNS SATURN T-AFS-10		119
USNS SEALIFT ANTARCTIC	46	
USNS SEALIFT MEDITERRA	29	18
USNS SEALIFT IND'N OCE	21	37
USNS SEALIFT CHINA SEA	25	54
USNS SEALIFT CARIBBEAN	108	152
USNS SEALIFT ARABIAN S	4	85
USNS SEALIFT ATLANTIC	149	136
USNS SEALIFT ARCTIC	30	15
USNS SILAS BENT T-AGS	26	
USNS SIRIUS (T-AFS 8)		86
USNS SPICA (T-AFS 9)		69
USNS VANGUARD TAG 194	86	
VALLEY FORGE	6	44
VIKING ACE	1	
VINE	159	
VISHVA SIDDHI	1	
VISHVA VIKRAM	5	
WASHINGTON RAINBOW #2	41	
WESTWARD	20	
WESTWARD VENTURE	58	168
WESTWOOD ANETTE	50	49
WESTWOOD BELINDA	12	16
WESTWOOD CLEO	97	82
WESTWOOD JAGO	98	133
WESTWOOD MARIANNE	12	80
WHITE ROSE	19	63
WILFRED SYKES	42	
WILLIAM J. DELANCEY	311	226
WILLIAM R. ROESCH	51	33
WINDWARD	1	
WINDWARD SENTRY	53	151
WINTER MOON	109	
WOLVERINE	2	
WORLD WING #2	28	66
YACU WAYO	7	
YAMATAKA MARU	39	
YANKEE CLIPPER	100	
YOUNG SKIPPER	59	
YOUNG SPROUT	70	106
ZEELANDIA	97	
ZIM AMERICA	45	
ZIM CALIFORNIA	31	
ZIM CANADA	50	
ZIM HAIFA	59	
ZIM HONGKONG	22	
ZIM HOUSTON	37	
ZIM IBERIA	26	
ZIM KEELUNG	60	
ZIM KINGSTON III	254	
ZIM MARSEILLES	61	
ZIM MIAMI	46	
ZIM SAVANNAH	12	
ZIM TOKYO	19	

SUMMARY: GRAND TOTAL VIA RADIO 49690

GRAND TOTAL VIA MAIL 46743

TOTAL UNIQUE OBS 77434

TOTAL DUPLICATES 18999 (24.5%)

UNIQUE RADIO OBS.30691 (39.6%)

UNIQUE MAIL OBS. 27744 (35.8%)

April, May and June 1991

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
ADRA	1	1	0	ACANIA
A3BE	38	38	0	COLUMBUS CANADA
A3BZ	39	39	0	ACT 12
A8VI	62	62	0	PACDUCHESS
CBVM	33	33	0	VINA DEL MAR
CGBS	45	0	45	PARIZEAU
CGDV	73	73	0	W. TEMPLEMAN
CG2965	71	71	0	RICKER
C6HL8	47	47	0	ACT 10
C6JZ2	23	23	0	ACT 3
C6JZ3	29	29	0	ACT 6
DAKE	182	182	0	KOELN ATLANTIC
DA9100	184	184	0	NORDSEE
DESI	54	35	19	VALDIVIA
DGLM	111	111	0	MONTE ROSA
DGVK	101	101	0	COLUMBUS VICTORIA
DGZV	106	106	0	COLUMBUS VIRGINIA
DHCW	93	93	0	COLUMBUS WELLINGTON
DHOU	16	16	0	PURITAN
DLEZ	34	34	0	YANKEE CLIPPER
D5BC	75	75	0	SEDCO/BP471
D5NZ	121	121	0	POLYNESIA
ELBX3	24	24	0	PACKING
ELDM8	5	5	0	SEAL ISLAND
ELED7	29	29	0	PACPRINCE
ELED8	56	56	0	PACPRINCESS
ELEH4	2	2	0	C R POINTE NOIRE
ELHL6	29	29	0	COLUMBUS OHIO
ELIS8	2	2	0	MARINER
ELJP8	1	1	0	CALIFORNIA ZEUS
EREA	225	175	50	MUSSON
EREC	124	10	114	PRILIV
EREH	18	15	3	PRIBOY
ERET	49	49	0	GEORGE OUSHAKOV
EREU	164	161	3	ERNST KRENKEL
ESGG	22	0	22	VYACHESLAV FROLOV
FAQV	5	5	0	BALNY
FITA	17	17	0	NOROIT
FNCZ	14	14	0	LIBREVILLE
FNGB	4	4	0	MARION DUFRESNE
FNGS	20	20	0	LA FAYETTE
FNJT	19	19	0	KORRIGAN
FNOM	20	20	0	ANGO
FNQB	26	26	0	ILE MAURICE
FNQM	10	10	0	VILLE DE MARSEILLE
FNZB	6	6	0	SAINT ROLAND
FNZO	26	26	0	RABELAIS
FNZP	1	1	0	RACINE
FNZQ	35	35	0	RIMBAUD
FPYO	3	3	0	CAP SAINT PAUL
GOVN	43	43	0	ACT 6
GPHH	66	66	0	FARNELLA
GQEK	38	38	0	FORTHBANK
GTIA	3	3	0	IVYBANK
GYRW	27	27	0	ENCOUNTER BAY
GYSA	6	6	0	FLINDERS BAY
GYSE	18	18	0	NEDLLOYD TASMAN
GZKA	29	29	0	ACT 3
HPAN	29	29	0	MICRONESIAN COMMERCE
HPEW	45	45	0	PACIFIC ISLANDER
H9BQ	37	37	0	MICRONESIAN INDEP.
JBOA	77	77	0	KEIFU MARU
JCCX	122	122	0	CHOFU MARU
JCDF	28	28	0	SOYO MARU
JCOD	9	9	0	SHOYO
JDWX	82	82	0	KOFU MARU
JFDG	87	87	0	SHUMPU MARU
JFPQ	42	42	0	***
JGZK	114	114	0	RYOFU MARU
JITV	113	113	0	WELLINGTON MARU
JNSR	49	49	0	***
JPVB	75	75	0	SEIFU MARU
JSVY	11	11	0	SHIRASE
J8FN	18	18	0	ROWEN BANK
J8FO	80	80	0	ROSEBANK
KGJB	63	63	0	SEALAND DEFENDER
KIRH	31	31	0	SEA-LAND TRADER
KNBD	69	51	18	DELAWARE II
KNDB	1	0	1	RAINBOW HOPE
KNFG	68	68	0	SEA WOLF
KRGB	104	104	0	SEA-LAND ENTERPRISE
KVWA	6	6	0	TEXAS CLIPPER
LADB2	104	104	0	SHAUGRAN
LADC2	79	79	0	SKAUBORD
LAJV4	71	71	0	SKAUBRYN
NBTM	18	18	0	POLAR STAR
NHDB	1	1	0	TRUETT
NHTE	1	1	0	ELROD
NHTM	39	39	0	***
NICB	25	25	0	***
NIDK	48	48	0	ICEPAT GROTON CT
NIKA	38	38	0	SEALIFT ATLANTIC
NJEC	1	1	0	TRIPPE
NMEL	75	75	0	MELLON
NOKB	13	13	0	***
NRCB	24	24	0	EAGLE
NRLC	2	2	0	CONOLLY
NRUO	6	6	0	POLAR SEA
NTWR	6	6	0	***
OWEQ2	10	10	0	MCKINNEY MAERSK
OWUQ6	86	86	0	MOANA PACIFIC COBENHAVN
PGDI	28	28	0	NEDLLOYD MANILA
PGEM	33	33	0	NEDLLOYD BARCELONA
PJJU	137	137	0	OLEANDER
PJYG	19	19	0	HIBISCUS
SHIP	640	640	0	***
S6FK	64	64	0	SWAN REEFER
TESTP	2	2	0	PACIFIC TEST
UBNZ	1	1	0	SHULEYKIN AKADEMIK
UEAK	37	3	34	VALERIAN URYVAYEV
UFJN	194	1	193	VILNYUS
UFYN	1	0	1	KAPITAN SHAYTANOV
UHQS	52	1	51	AKADEMIK KOROLEV
UINF	24	22	2	VLADIMIR PARSHIN
UMWZ	1	1	0	NIRNY
UWEC	6	0	6	PROFESSOR KHROMOV
UZGH	145	138	7	PASSAT
VCTF	11	11	0	CAPE BRIER
VC9616	30	30	0	LADY HAMMOND
VJBQ	2	2	0	ANRO AUSTRALIA
VJDI	11	11	0	IRON NEWCASTLE
VJDP	5	5	0	IRON PACIFIC
VKCK	26	26	0	STUART
VKCV	3	3	0	DERWENT
VKDA	59	59	0	DARWIN
VKLA	64	64	0	ADELAIDE
VKLC	1	1	0	BRISBANE
VKML	26	26	0	SYDNEY
VKPT	137	137	0	PERTH
VXN8	296	296	0	AIRCRAFT
V2PM	71	71	0	WEST MOOR
WCGN	3	3	0	CHEVRON CALIFORNIA
WLDZ	14	14	0	***
WPGK	39	39	0	NAVIGATOR
WPKD	193	193	0	SEA-LAND ACHIEVER
WRBA	8	8	0	PACMISRANFAC HAWAREA
WRBB	4	4	0	***
WSRL	46	46	0	SEA-LAND PACIFIC
WTDF	37	37	0	T. CROMWELL
WTDK	13	0	13	D.S. JORDAN
WTDM	70	42	28	M.FREEMAN
WTDO	43	26	17	OREGON II
WTEA	64	58	6	DISCOVERER
WTED	37	37	0	CHAPMAN
WTEF	9	9	0	RAINIER
WTEG	33	32	1	MOUNT MITCHELL
WTER	85	74	11	M. BALDRIDGE
WTES	80	70	10	SURVEYOR
WTEW	61	57	4	WHITING
WTEZ	7	4	3	FERREL
WUS9293	158	158	0	MOANA WAVE
Y3CH	14	0	14	PROF. ALBRECHT PENCK
Y3CW	40	0	40	A.V. HUMBOLDT
ZCKP	86	86	0	STAR HONG KONG
ZDBE9	50	50	0	VOYAGER
ZMCR	2	2	0	CANTERBURY
3EET4	29	29	0	SEAS EIFFEL
7JJX	20	20	0	***
7KDD	33	33	0	YOKO MARU
9V8Z	11	11	0	MAHSURI
9VUU	2	2	0	ANRO ASIA
9VVB	41	41	0	GOLDENSARI INDAH
9VWH	12	12	0	***
32315	66	66	0	BUOY
32316	50	50	0	BUOY
32317	31	31	0	BUOY
32318	50	50	0	BUOY
42520	91	91	0	BUOY
42520B	37	37	0	BUOY
51006	16	16	0	BUOY
51007	67	67	0	BUOY
51008	59	59	0	BUOY
51009	123	123	0	BUOY
51010	102	102	0	BUOY
51011	22	22	0	BUOY
51014	22	22	0	BUOY
52001	35	35	0	BUOY
52002	15	15	0	BUOY
52003	13	13	0	BUOY
52004	13	13	0	BUOY
52006	15	15	0	BUOY
52301	33	33	0	BUOY

TOTAL BATHYS RECEIVED 8345
TOTAL TESACS RECEIVED 716
TOTAL REPORTS RECEIVED 9061

NDBC Station Data Summary

April, May and June 1991

Wave observations are taken each hour during a 20–minute averaging period, with a sample taken every 0.67 seconds. The significant wave height is defined as the average height of the highest one–third of the waves during the average period each hour. The maximum significant wave height is the highest of those values for that month. At most stations, air temperature, water temperature, wind speed and direction are sampled once per second during an 8.0–minute averaging period each hour (moored buoys) and a 2.0–minute averaging period for fixed stations (C–MAN). Contact NDBC Data Systems Division, Bldg 1100, SSC, Mississippi 39529 or phone (601) 688–2838 for more details.

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
APRIL		1991											
32302	18.0S	085.1W	0715	20.9	22.2	2.0	3.5	17/22	12.6	SE	20.0	17/23	1015.6
33301	56.3S	027.6W	0389	-0.2									1000.1
41001	34.9N	072.9W	0054	20.6	20.5	1.2	1.6	29/16	10.4	SW	20.4	29/13	1018.3
41002	32.3N	075.2W	0718	20.9	22.3	1.5	3.5	22/02	11.4	SW	26.2	21/20	1018.8
41008	30.7N	081.1W	0718	20.9	21.0	1.0	2.5	04/11	8.3	S	22.5	23/17	1018.0
41009	28.5N	080.2W	1433	23.5	23.7	1.2	4.0	04/21	11.7	SE	26.0	25/22	1017.3
41010	28.9N	078.5W	1434	23.3	24.7	1.4	4.0	04/13	13.2	E	25.1	04/13	1018.1
42001	25.9N	089.7W	0717	24.3	24.2	1.3	3.4	29/07	13.1	SE	30.3	27/09	1013.9
42002	25.9N	093.6W	0626	24.3	24.3	1.4	2.9	29/02	13.7	SE	27.6	12/07	1012.0
42003	25.9N	085.9W	0703	25.1	26.0	1.1	2.4	03/16	13.2	SE	26.2	20/05	1015.2
42007	30.1N	088.8W	0694	21.3	22.1				12.9	SE	39.1	30/06	1015.5
42019	27.9N	095.0W	0719	23.2	23.3	1.4	3.8	13/22	11.6	SE	25.6	13/18	1011.5
42020	27.0N	096.5W	0720	22.9	22.6	1.3	3.0	13/19	11.2	SE	27.6	07/07	1010.9
44001	38.4N	073.7W	0131	9.0	9.8	0.7	1.7	01/06	8.5	SW	14.8	06/02	1027.4
44004	38.5N	070.7W	0715	12.0	12.0	1.7	4.7	21/20	11.9	SW	35.6	21/18	1019.9
44005	42.7N	068.6W	0714	5.4	4.8	1.4	5.1	21/20	10.9	SW	32.3	21/17	1017.4
44007	43.5N	070.1W	0719	5.7	5.1	0.9	5.5	22/00	11.0	S	41.8	21/20	1017.8
44008	40.5N	069.4W	0717	7.3	6.2	1.4	5.1	22/00	13.2	SW	33.0	21/23	1018.5
44009	38.5N	074.7W	0718	10.5	12.3	1.0	3.7	21/11					1018.4
44011	41.1N	066.6W	0718	6.3	5.2	1.8	5.8	22/02	11.9	SW	30.1	19/02	1017.4
44012	38.8N	074.6W	0715	10.2	9.0	1.0	3.5	21/12	13.6	S	34.6	21/08	1020.1
44013	42.4N	070.8W	0718	8.0	6.0	0.7	4.9	21/19	12.0	SW	39.8	21/15	1017.8
44014	36.6N	074.8W	0715	13.3	13.7	1.2	4.3	21/01	10.2	S	30.1	21/07	1018.7
44015	37.5N	073.4W	0089	9.0	9.2	0.7	2.6	01/07	8.9	N	19.4	01/09	1027.3
44023	37.5N	074.4W	0121	8.9	8.8	0.8	1.8	01/09	7.6	N	20.4	01/05	1027.9
44025	40.3N	073.2W	0026	9.6	8.7	0.8	1.2	29/22	7.4	E	12.2	30/12	1018.0
45002	45.3N	086.4W	0719	3.9	2.5	0.6	2.8	10/13					1015.3
45003	45.3N	082.7W	0167	4.8	2.3	0.4	1.1	30/19	9.5	E	19.6	30/13	1013.8
45004	47.5N	086.5W	0715		1.4	0.6	2.8	10/11	10.3	SE	20.7	29/23	
45005	41.7N	082.4W	0670	6.9	5.9	0.7	2.5	15/18	10.4	NE	30.3	15/17	1015.7
45006	47.3N	089.9W	0358	3.1	1.2	0.7	2.1	19/17	8.4	E	18.4	19/11	1013.5
45007	42.8N	087.1W	0719	5.2	3.2				10.7	S	22.7	10/10	1014.5
45008	44.3N	082.4W	0179	4.9	2.4	0.5	1.4	30/20	7.7	SE	15.0	30/20	1013.6
46001	56.3N	148.3W	0167	4.3	4.6	3.2	5.5	26/22	14.6	SE	26.4	25/14	1000.6
46002	42.5N	130.4W	0719	9.8	10.7	2.7	7.7	05/03	13.0	N	27.8	03/08	1021.9
46003	51.9N	155.9W	0720	3.4	3.7	3.5	8.6	02/21	16.2	W	34.4	10/15	1001.9
46005	46.1N	131.0W	0720	7.9	8.8	2.8	6.8	04/19	13.5	W	29.0	23/10	1018.8
46010	46.2N	124.2W	0307	8.5	9.3	2.9	6.7	05/01	14.6	SW	34.8	03/19	1020.5
46011	34.9N	120.9W	0717	11.7	11.7	2.3	5.2	11/06	15.0	NW	33.4	11/01	1018.3
46012	37.4N	122.7W	0179	11.5	12.1	2.6	4.2	05/18	13.7	NW	28.3	07/06	1022.5
46013	38.2N	123.3W	0720	10.5	10.4	2.3	5.8	05/11	15.8	N	35.7	11/02	1019.6
46014	39.2N	124.0W	0718	10.3	10.5	2.4	6.4	05/16	12.5	NW	33.5	11/02	1020.5
46022	40.8N	124.5W	0720	9.8	10.3	2.3	6.4	05/16	10.2	N	29.3	11/04	1021.2
46023	34.3N	120.7W	0719	11.7	11.8	2.5	6.3	11/05	17.8	NW	35.8	11/02	1016.8
46025	33.8N	119.1W	0717	13.9	14.6	1.2	3.0	11/02	7.0	W	28.6	26/11	1015.6
46026	37.8N	122.7W	0717	10.4	10.5	1.7	3.6	05/15	14.9	NW	30.7	07/06	1019.4
46027	41.8N	124.4W	0714	9.1	9.5	2.0	4.4	05/10	10.5	N	29.9	11/02	1020.8
46028	35.8N	121.9W	0718	11.3	11.3	2.5	5.4	05/12	16.4	NW	30.7	07/23	1019.1
46030	40.4N	124.5W	0665	9.7		2.1	6.1	05/09	10.4	N	31.5	11/05	1020.6
46035	57.0N	177.7W	0719	-0.5	1.6	1.7	4.5	19/03	13.2	N	25.5	16/03	1005.0
46040	44.8N	124.3W	0719	9.1	9.6	2.5	7.5	04/22	11.9	N	31.3	04/01	1019.7
46041	47.4N	124.5W	0719	8.2	9.9	2.2	6.3	03/23	10.0	NW	29.1	03/17	1018.2
46042	36.8N	122.4W	0717	11.0	11.5	2.3	5.1	05/08	14.6	NW	29.5	11/04	1019.8
46045	33.8N	118.5W	0718	14.1	14.5	1.0	2.6	11/03	6.1	W	23.1	11/10	1015.8
51001	23.4N	162.3W	0719	22.7	23.5	2.4	3.9	12/20	14.2	E	21.6	06/00	1019.9
51002	17.2N	157.8W	0712	24.1		2.6	4.5	06/19	17.5	NE	26.8	04/16	1016.2
51003	19.2N	160.8W	0599	24.3	24.7	2.2	3.9	06/23	11.8	E	19.6	06/17	1016.4
51004	17.5N	152.5W	0715	23.8	24.4	2.7	4.2	06/14	16.5	E	24.7	06/13	1016.3
ALSN6	40.5N	073.8W	0716	10.1	8.1	0.9	2.8	21/14	16.0	SW	39.6	11/02	1018.6
BURL1	28.9N	089.4W	0719	20.8					13.2	SE	42.1	30/12	1014.3
BUZM3	41.4N	071.0W	0716	7.7					15.2	SW	37.7	22/01	1018.6
CARO3	43.3N	124.4W	0720	9.1					10.6	N	34.8	24/03	1021.0
CHLV2	36.9N	075.7W	0719	13.5	12.0	0.9	3.4	20/19	15.2	S	40.3	20/21	1019.0
CLKN7	34.6N	076.5W	0713	17.5					10.3	SW	26.4	19/13	1019.5
CSBF1	29.7N	085.4W	0658	21.5					6.8	SE	33.1	26/00	1016.9
DBLN6	42.5N	079.4W	0720	8.7					12.9	SW	37.1	10/20	1016.4
DESW1	47.7N	124.5W	0720	8.0					11.4	W	42.7	03/13	1018.5
DISW3	47.1N	090.7W	0714	4.1					11.4	NE	38.0	30/22	1016.0
DPIA1	30.3N	088.1W	0716	20.9	22.0				12.0	SE	35.5	30/10	1015.6

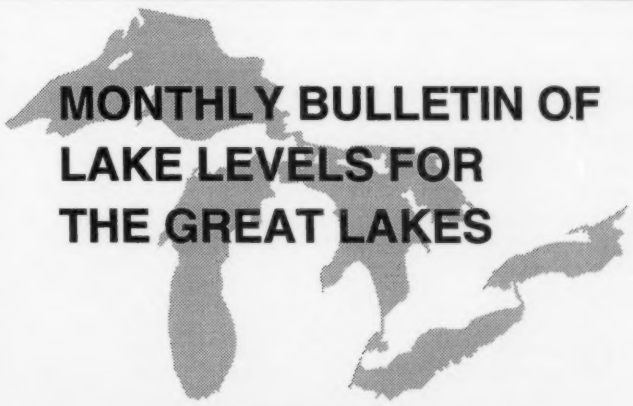
BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
DSLN7	35.2N	075.3W	0691	17.6	18.6	1.2	3.2	20/15	15.1	SW	31.4	20/12	1019.0
ENIP2	11.4N	162.4E	0706	27.2					17.6	E	27.8	02/01	1009.9
FBIS1	32.7N	079.9W	0718	19.2					9.3	E	30.0	18/00	1018.6
FFIA2	57.3N	133.6W	0719	5.6					9.8	SE	38.6	12/00	1014.2
FPSN7	33.5N	077.6W	0718	19.6	19.5				13.8	SW	29.8	19/19	1018.8
GBCL1	27.8N	093.1W	0714	22.7	23.3	1.3	3.0	28/22	15.1	SE	32.7	28/14	1012.9
GDIL1	29.3N	090.0W	0719	21.7	23.2				11.5	SE	37.4	26/15	1014.9
GLLN6	43.9N	076.5W	0720	6.3					11.7	W	34.7	11/00	1016.4
IOSN3	43.0N	070.6W	0695	7.4					13.1	NE	45.9	21/19	1018.3
KOSP2	5.4N	163.0E	0167	26.3					5.6	E	16.1	02/15	1010.3
LKWF1	26.6N	080.0W	0717	24.2	25.3				13.2	SE	29.2	04/02	1017.1
MDRM1	44.0N	068.1W	0717	4.6					13.1	SW	45.0	21/20	1016.9
MISM1	43.8N	068.9W	0674	4.9					13.9	SW	51.9	21/22	1017.2
MLIP2	6.1N	172.6E	0716	27.3					9.7	NE	26.1	01/12	1008.4
MLRF1	25.0N	080.4W	0716	25.2	25.9				13.7	SE	31.2	20/15	1016.4
MPCL1	29.4N	088.6W	0708	23.1	21.7	1.2	3.2	26/05	13.6	SE	37.6	30/06	1015.2
NWPO3	44.6N	124.1W	0720	8.6					10.0	SW	37.0	04/20	1020.2
PAGP2	18.1N	145.8E	0568	27.0					9.2	E	16.3	13/04	
PILM4	48.2N	088.4W	0720	2.6					11.1	E	29.1	27/16	1016.9
PTAC1	39.0N	123.7W	0720	9.6					9.2	N	28.3	10/05	1020.7
PTAT2	27.8N	097.1W	0720	22.3	22.9				11.7	SE	28.9	05/17	1010.7
PTGC1	34.6N	120.7W	0719	11.3					17.7	N	40.0	10/20	1017.5
ROAM4	47.9N	089.3W	0689	4.0	1.1				12.3	NE	43.9	27/22	1017.5
SANF1	24.5N	081.9W	0717	25.3					13.7	E	28.5	20/18	1016.0
SAUF1	29.9N	081.3W	0716	21.2	22.0				8.2	SE	25.9	25/23	1017.6
SBIO1	41.6N	082.8W	0720	9.5					14.0	SW	47.0	15/17	1015.9
SGNW3	43.8N	087.7W	0716	7.0					12.1	S	33.5	19/20	1015.4
SISW1	48.3N	122.9W	0719	8.3					8.7	W	41.0	03/13	1018.6
SMKF1	24.6N	081.2W	0711	25.5	25.8				14.2	SE	37.4	20/14	1016.6
SPGF1	26.7N	079.0W	0716	24.2	25.9				8.3	SE	26.4	03/23	1017.1
SRST2	29.7N	094.1W	0719	21.4					12.5	SE	28.1	05/22	1013.1
STDM4	47.2N	087.2W	0717	4.1					15.9	S	34.0	04/00	1016.5
SVLS1	32.0N	080.7W	0714	19.2		0.9	2.2	04/03	11.5	NE	26.6	12/23	1018.1
TPLM2	38.9N	076.4W	0717	12.4	11.7				11.1	S	29.2	11/02	1018.4
TTIW1	48.4N	124.7W	0720	7.5					10.2	SW	37.0	03/18	1018.7
UJAP2	8.9N	165.8E	0718	27.3					15.0	E	27.6	28/13	1009.6
VENF1	27.1N	082.5W	0718	23.3	25.8				8.7	E	30.9	25/20	1017.1
WPOW1	47.7N	122.4W	0720	8.7					8.7	S	26.6	03/22	1017.6
MAY		**1991**											
32302	18.0S	085.1W	0743	20.4	21.8	1.9	3.5	20/02	9.4	SE	20.4	20/00	1015.9
33301	56.3S	027.6W	0395	-2.3									986.0
41001	34.9N	072.9W	0743	21.7	22.8	1.3	3.0	19/23	10.9	SW	22.3	03/19	1019.5
41002	32.3N	075.2W	0744	24.0	24.9	1.3	3.3	20/12	10.4	SW	26.2	02/08	1019.2
41008	30.7N	081.1W	0744	24.9	25.3	0.8	1.9	21/20	9.2	SE	20.6	01/22	1018.2
41009	28.5N	080.2W	1050	25.5	25.6	0.8	2.6	22/03	9.7	E	21.6	22/11	1018.0
41010	28.9N	078.5W	1485	25.4	26.1	1.1	2.6	22/14	11.8	SE	22.9	07/06	1018.6
42001	25.9N	089.7W	0739	26.2	26.5	1.0	3.4	22/19	12.0	SE	26.0	18/09	1013.5
42002	25.9N	093.6W	0741	26.4	26.7	1.3	2.9	23/04	13.3	SE	25.8	17/15	1011.6
42003	25.9N	085.9W	0743	26.5	27.3	1.0	4.7	22/04	11.2	SE	26.6	22/00	1014.6
42007	30.1N	088.8W	0717	24.8	25.7				12.4	SE	28.2	21/07	1015.2
42019	27.9N	095.0W	0744	25.5	26.0	1.4	3.1	02/11	12.3	SE	36.1	02/11	1011.6
42020	27.0N	096.5W	0688	25.6	25.7	1.3	3.3	23/14	11.9	SE	28.2	02/12	1011.4
44004	38.5N	070.7W	0203	14.4	14.3	1.3	3.3	07/03	11.2	NW	24.3	04/00	1017.4
44005	42.7N	068.6W	0744	9.6	8.1	1.0	3.2	18/13	10.1	SW	27.2	07/03	1016.1
44007	43.5N	070.1W	0743	11.6	9.5	0.6	2.3	07/03	10.4	S	25.3	04/01	1016.3
44008	40.5N	069.4W	0744	10.5	8.3	0.9	3.2	18/22	10.5	W	27.4	18/11	1018.0
44009	38.5N	074.7W	0743	17.0	15.8	0.7	2.8	19/00	10.5	SW	24.9	18/14	1018.6
44011	41.1N	066.6W	0743	9.2	7.4	1.3	3.9	18/19	9.4	SW	28.8	18/14	1016.4
44012	38.8N	074.6W	0744	16.5	14.7	0.6	2.5	18/19	11.2	S	28.2	18/14	1018.4
44013	42.4N	070.8W	0744	14.0	11.1	0.4	2.0	18/18	11.1	SW	28.8	18/03	1016.9
44014	36.6N	074.8W	0744	17.6	17.5	0.9	3.2	19/12	7.8	S	23.9	19/02	1019.4
44025	40.3N	073.2W	0727	14.8	13.5	0.8	2.1	18/14	9.2	SW	21.6	18/12	1017.8
45001	48.1N	087.8W	0674	4.8	2.1	0.5	2.1	06/19	8.7	SE	24.9	06/12	1016.4
45002	45.3N	086.4W	0743	7.2	3.6	0.4	2.4	01/00	8.7	S	19.3	29/11	1016.2
45003	45.3N	082.7W	0742	5.5	2.8	0.5	1.5	07/21	7.9	SW	21.0	06/02	1017.2
45004	47.5N	086.5W	0739	5.3	2.4	0.6	3.3	01/10	9.2	SE	20.5	26/15	1016.8
45005	41.7N	082.4W	0737	14.6	14.1	0.6	2.3	18/18	8.4	SW	23.3	07/01	1017.3
45006	47.3N	089.9W	0744	4.5	2.2	0.7	3.2	01/01	9.0	E	23.8	01/01	1016.6
45007	42.8N	087.1W	0726	10.2	7.4				7.6	S	22.3	31/00	1015.7
45008	44.3N	082.4W	0744	7.0	4.6	0.6	2.2	17/20	7.4	S	19.6	06/14	1017.8
46001	56.3N	148.3W	0743	5.3	5.7	2.4	10.1	09/20	14.3	W	32.6	18/04	1008.6
46002	42.5N	130.4W	0743	11.1	11.9	2.3	4.7	01/11	13.6	NW	26.0	01/11	1022.9
46003	51.9N	155.9W	0743	4.8	4.6	2.8	12.1	09/08	15.0	W	33.8	09/07	1008.4
46005	46.1N	131.0W	0741	9.3	9.9	2.3	3.9	09/14	13.5	NW	30.5	15/21	1020.5
46011	34.9N	120.9W	0744	10.9	10.6	2.2	4.5	10/07	14.0	NW	28.5	31/03	1016.7
46013	38.2N	123.3W	0741	10.3	9.5	2.3	4.9	10/04	17.6	N	32.5	09/23	1016.6
46014	39.2N	124.0W	0742	10.2	9.6	2.3	4.5	10/04	15.3	NW	32.1	10/00	1017.6
46022	40.8N	124.5W	0742	9.9	9.9	2.3	4.7	11/04	11.4	N	26.4	10/04	1019.2
46023	34.3N	120.7W	0744	10.9	10.8	2.4	4.6	10/07	17.9	NW	29.6	09/11	1015.3
46025	33.8N	119.1W	0743	13.3	14.6	1.4	3.4	18/07	8.1	W	30.5	18/04	1014.0
46026	37.8N	122.7W	0744	10.0	9.9	1.7	3.4	10/02					1016.7
46027	41.8N	124.4W	0741	9.1	8.7	2.0	4.1	23/02	13.4	N	34.6	22/02	1018.6
46028	35.8N	121.9W	0744	11.3	11.7	2.6	4.7	10/14	16.9	NW	28.5	10/05	1017.3
46030	40.4N	124.5W	0736	9.7		2.1	4.2	10/05	12.8	N	26.4	10/04	1018.8
46035	57.0N	177.7W	0273	1.3	2.1	2.0	4.8	04/02	14.5	NE	31.3	04/00	994.1
46040	44.8N	124.3W	0742	10.3	10.6	2.1	5.0	18/07	10.4	N	28.0	29/21	1019.2
46041	47.4N	124.5W	0744	10.2	11.1	1.9	4.3	18/03	10.0	NW	23.1	29/23	1017.9
46042	36.8N	122.4W	0744	10.5	10.7	2.3	4.5	10/05	13.7	NW	25.5	10/00	1017.6
46045	33.8N	118.5W	0743	13.6	14.4	1.1	3.4	18/07	6.3	SW	24.3	09/22	1014.2
51001	23.4N	162.3W	0744	23.7	24.6	2.0	3.1	03/21	12.9	E	24.1	28/15	1019.4
51002	17.2N	157.8W	0736	24.5		2.3	3.3	12/11	15.5	E	22.2	01/16	1016.1
51003	19.2N	160.8W	0740	24.8	25.6	2.0	3.0	03/16	11.5	E	20.8	06/22	1016.6
51004	17.5N	152.5W	0458	23.9	24.5	2.2	3.2	01/07	14.7	NE	22.8	06/09	1016.5

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
91222	18.1N	145.8E	0604	28.1					7.6	E	17.1	10/03	
91251	11.4N	162.4E	0709	27.5					15.9	E	22.3	02/09	1010.5
91365	8.9N	165.8E	0742	27.7					13.9	E	23.9	01/14	1010.5
91377	6.1N	172.6E	0740	27.5					9.6	NE	28.2	30/01	1009.4
ALSN6	40.5N	073.8W	0744	16.7	13.9	0.7	1.7	18/19	14.2	NW	31.2	18/09	1018.2
BURL1	28.9N	089.4W	0744	24.2					11.7	SE	34.4	09/06	1014.2
BUZM3	41.4N	071.0W	0742	13.2					13.6	SW	32.5	06/21	1018.1
CARO3	43.3N	124.4W	0744	10.0					9.1	N	28.8	29/20	1020.2
CHLV2	36.9N	075.7W	0743	19.6	18.5	0.7	3.0	19/03	13.0	S	33.1	19/15	1019.4
CLKN7	34.6N	076.5W	0728	22.8					8.9	SW	23.7	19/02	1019.9
CSBF1	29.7N	085.4W	0695	25.2					6.9	SE	27.6	27/15	1016.8
DBLN6	42.5N	079.4W	0744	15.4					10.2	SW	34.6	01/19	1017.8
DESW1	47.7N	124.5W	0744	10.1					11.0	W	29.8	07/19	1018.3
DISW3	47.1N	090.7W	0743	7.1					11.0	NE	31.7	01/05	1016.5
DPIA1	30.3N	088.1W	0744	24.4	25.0				11.3	SE	35.7	26/07	1015.4
DSLN7	35.2N	075.3W	0701	22.9	23.8	1.0	2.9	19/08	13.4	SW	28.5	07/01	1019.3
FBIS1	32.7N	079.9W	0744	24.2					9.2	SW	25.2	20/16	1018.7
FFIA2	57.3N	133.6W	0744	8.5					8.6	S	30.6	28/23	1015.5
FPSN7	33.5N	077.6W	0744	24.3	24.3				12.5	SW	28.8	20/23	1019.2
GBCL1	27.8N	093.1W	0740	25.1	26.0	1.2	3.4	22/23	14.8	SE	29.9	15/22	1012.8
GDIL1	29.3N	090.0W	0743	25.0	26.6				10.7	SE	28.5	15/10	1014.7
GLLN6	43.9N	076.5W	0743	12.1					10.7	SW	46.9	01/21	1016.9
IOSN3	43.0N	070.6W	0741	13.8					12.5	S	34.6	06/22	1017.0
LKWF1	26.6N	080.0W	0744	26.1	26.9				12.6	SE	32.1	22/13	1017.1
MDRM1	44.0N	068.1W	0744	8.7					13.6	SW	38.0	07/03	1015.0
MISM1	43.8N	068.9W	0702	9.8					13.9	SW	43.4	07/02	1015.3
MLRF1	25.0N	080.4W	0742	26.5	27.3				13.0	SE	31.5	21/12	1016.1
MPCL1	29.4N	088.6W	0737	25.7	25.4				13.1	E	34.9	22/15	1014.8
NWPO3	44.6N	124.1W	0743	9.8					8.0	NW	31.0	07/19	1019.5
PILM4	48.2N	088.4W	0744	6.0					10.6	E	33.0	01/07	1016.7
PTAC1	39.0N	123.7W	0743	9.7					11.2	N	25.8	10/02	1017.8
PTAT2	27.8N	097.1W	0744	25.1	26.3				13.4	SE	35.1	02/12	1011.0
PTGC1	34.6N	120.7W	0743	10.6					18.1	N	38.1	09/07	1016.0
ROAM4	47.9N	089.3W	0742	7.9	2.5				12.5	NE	33.0	06/14	1017.4
SANF1	24.5N	081.9W	0742	26.6	27.7				12.4	SE	35.7	22/03	1015.5
SAUF1	29.9N	081.3W	0742	24.9	26.1				10.0	SE	27.5	01/20	1017.7
SBIO1	41.6N	082.8W	0743	17.3					9.9	E	29.6	07/16	1017.1
SGNW3	43.8N	087.7W	0744	12.1					10.3	S	30.9	17/17	1016.1
SISW1	48.3N	122.9W	0744	10.4					8.9	W	29.0	08/19	1017.9
SMKF1	24.6N	081.2W	0740	26.8	27.2				12.8	E	36.4	22/02	1016.2
SPGF1	26.7N	079.0W	0743	26.1	27.7				8.0	SE	21.0	20/16	1017.1
SRST2	29.7N	094.1W	0744	24.4					11.9	SE	34.6	02/01	1013.3
STDM4	47.2N	087.2W	0744	8.9					14.9	E	37.0	01/06	1016.6
SVLS1	32.0N	080.7W	0382	23.5		0.7	1.6	06/03	10.2	S	27.7	02/01	1018.6
TPLM2	38.9N	076.4W	0744	20.1	19.4				9.6	S	26.5	02/14	1018.4
TTIW1	48.4N	124.7W	0744	9.4					8.9	W	28.0	08/13	1018.5
VENF1	27.1N	082.5W	0744	25.2	28.8				7.4	E	17.5	22/15	1016.8
WPOW1	47.7N	122.4W	0742	11.0					6.9	S	21.2	08/03	1016.9
JUNE		**1991**											
32302	18.0S	085.1W	0718	19.3	20.8	2.0	3.7	03/14	12.8	SE	22.9	03/10	1017.8
33301	56.3S	027.6W	0360	-4.3									992.7
41001	34.9N	072.9W	0720	23.6	24.4	1.4	3.8	24/09	10.8	SW	22.2	24/05	1016.4
41002	32.3N	075.2W	0718	25.3	26.3	1.4	3.4	06/22	11.7	SW	26.6	06/18	1016.1
41008	30.7N	081.1W	0720	25.8	26.7	0.9	2.8	06/18	9.9	NE	25.3	07/02	1016.2
41009	28.5N	080.2W	0248	27.5	28.4	1.0	1.5	26/20	5.0	N	20.0	27/02	1016.5
41010	28.9N	078.5W	0961	26.0	26.6	1.2	4.7	07/09	11.3	S	29.9	02/23	1015.8
42001	25.9N	089.7W	0345	27.2	28.1	0.8	2.5	08/02	8.9	SE	20.8	08/02	1014.3
42002	25.9N	093.6W	0611	27.7	28.5	1.0	3.1	28/21	10.2	SE	28.4	28/20	1013.6
42003	25.9N	085.9W	0719	27.3	28.3	0.6	2.7	07/11	7.0	E	22.0	04/23	1016.0
42007	30.1N	088.8W	0689	27.1	28.4				10.2	SW	23.9	07/07	1015.6
42019	27.9N	095.0W	0256	27.3	28.0	1.3	3.0	08/11	10.1	SE	23.5	08/07	1012.5
42020	27.0N	096.5W	0633	28.2	28.7	1.2	3.9	29/03	11.2	SE	29.9	29/16	1013.1
44004	38.5N	070.7W	0464	20.6	20.0	1.4	3.2	24/01	9.8	SW	25.8	23/22	1016.4
44005	42.7N	068.6W	0719	13.3	12.1	1.0	2.7	05/11	9.6	SW	22.5	04/19	1013.4
44007	43.5N	070.1W	0717	15.1	12.5	0.5	1.6	04/18	9.5	SW	26.0	04/16	1013.9
44008	40.5N	069.4W	0719	13.5	11.2	1.1	3.2	05/12	11.2	SW	26.4	04/22	1015.4
44009	38.5N	074.7W	0718	21.0	20.6	0.9	2.9	24/01	10.0	S	28.2	23/16	1016.1
44011	41.1N	066.6W	0656	12.8	11.1	1.5	4.3	05/12	10.4	SW	29.9	05/10	1014.0
44012	38.8N	074.6W	0719	20.6	20.0	0.9	2.5	23/18	10.4	S	28.0	23/15	1015.8
44013	42.4N	070.8W	0717	18.0	16.2	0.5	2.3	05/00	10.9	SW	37.9	12/21	1014.7
44014	36.6N	074.8W	0719	21.7	21.7	1.0	2.3	05/14	9.0	NE	26.0	23/21	1016.6
44025	40.3N	073.2W	0698	19.6	18.8	0.9	2.0	05/05	10.5	SW	24.1	13/08	1015.4
45001	48.1N	087.8W	0715	6.2	3.2				7.7	S	27.8	26/15	1017.2
45002	45.3N	086.4W	0719	15.1	12.8	0.6	2.0	27/12	9.0	SW	17.5	28/00	1017.1
45003	45.3N	082.7W	0719	10.8	7.8				7.2	NW	21.0	29/17	1017.4
45004	47.5N	086.5W	0718	7.8	3.5	0.3	1.1	12/07	9.1	SE	22.3	27/12	1017.2
45005	41.7N	082.4W	0719	21.1	21.2	0.5	2.4	23/11	8.2	SW	30.5	16/02	1016.6
45006	47.3N	089.9W	0718	7.0	3.3	0.4	1.4	29/07	7.8	E	22.4	29/06	1017.7
45007	42.8N	087.1W	0718	18.3	17.3	0.5	1.9	22/06	7.8	N	22.0	23/00	1016.3
45008	44.3N	082.4W	0718	14.8	13.5	0.6	1.6	21/20	7.3	N	18.1	21/18	1017.7
46001	56.3N	148.3W	0719	7.7	8.1	1.7	4.3	04/05	10.1	W	27.8	04/00	1014.6
46002	42.5N	130.4W	0719	12.8	13.6	1.8	4.3	16/01	12.5	NW	21.6	02/13	1022.2
46003	51.9N	155.9W	0719	6.5	6.4	2.1	4.8	23/15	12.2	SW	28.4	23/10	1013.9
46005	46.1N	131.0W	0720	11.2	11.7	1.8	4.9	15/16	11.0	NW	26.0	15/16	1020.4
46011	34.9N	120.9W	0715	11.8	12.0	1.8	3.2	01/00	10.4	NW	22.5	20/04	1015.2
46013	38.2N	123.3W	0720	10.6	9.9	2.0	4.4	13/06	15.8	N	33.0	13/02	1014.1
46014	39.2N	124.0W	0720	10.7	10.0	2.2	4.8	04/02	15.1	NW	34.6	13/02	1015.1
46022	40.8N	124.5W	0719	10.6	10.0	2.0	5.8	04/07	9.5	N	31.3	05/01	1017.5
46023	34.3N	120.7W	0719	12.0	12.9	1.9	3.2	13/23	14.4	NW	27.2	20/00	1013.9
46025	33.8N	119.1W	0720	14.7	16.5	0.9	1.7	24/08	5.6	W	15.2	26/02	1013.8
46026	37.8N	122.7W	0716	10.7	11.1	1.5	3.3	13/06	10.9	W	24.9	16/04	1014.5
46027	41.8N	124.4W	0720	9.8	8.6	1.9	4.3	04/03	12.9	N	37.3	04/00	1016.9

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
46028	35.8N	121.9W	0719	11.9	12.2	2.2	3.9	13/14	13.3	NW	27.2	20/11	1015.3
46030	40.4N	124.5W	0718	9.9		1.9	4.5	04/07	13.0	N	25.3	03/13	1016.9
46040	44.8N	124.3W	0718	12.0	12.1	1.6	3.7	16/08	10.0	N	25.6	18/03	1018.7
46041	47.4N	124.5W	0719	11.3	11.6	1.4	2.9	12/11	8.2	NW	18.3	18/05	1018.1
46042	36.8N	122.4W	0719	11.4	11.6	2.0	4.2	13/11	11.3	NW	22.3	01/00	1015.4
46045	33.8N	118.5W	0719	15.4	17.2	0.8	1.5	22/08	5.7	SW	13.6	26/22	1013.8
51001	23.4N	162.3W	0720	24.4	25.2	2.1	3.2	08/11	13.5	E	21.2	07/17	1018.5
51002	17.2N	157.8W	0714	25.0		2.2	3.2	26/21	15.6	E	22.2	26/17	1015.4
51003	19.2N	160.8W	0717	25.5	26.2	1.8	2.6	10/13	11.0	E	18.4	08/04	1015.8
91222	18.1N	145.8E	0712	28.6					7.0	E	17.3	16/04	
91251	11.4N	162.4E	0713	27.7					12.4	E	25.8	09/00	1010.3
91365	8.9N	165.8E	0714	27.9					11.3	E	26.6	02/01	1010.4
91377	6.1N	172.6E	0711	27.6					7.6	NE	21.8	05/22	1009.4
ALSN6	40.5N	073.8W	0693	20.6	19.1	0.8	2.0	26/17	13.0	W	33.9	13/08	1016.0
BURL1	28.9N	089.4W	0720	27.0					9.4	SW	28.1	07/04	1015.4
BUZM3	41.4N	071.0W	0717	17.0					13.8	SW	33.6	13/08	1015.8
CARO3	43.3N	124.4W	0719	11.4					7.8	N	24.9	04/06	1019.4
CHLV2	36.9N	075.7W	0718	22.6	22.7	0.9	2.8	23/20	11.6	NE	29.4	23/21	1016.7
CLKN7	34.6N	076.5W	0695	24.5					10.5	SW	26.9	06/21	1017.2
CSBF1	29.7N	085.4W	0700	26.3					6.8	SW	16.7	04/22	1016.3
DBLN6	42.5N	079.4W	0718	19.5					9.3	SW	26.8	16/02	1017.7
DESW1	47.7N	124.5W	0720	11.2					9.6	W	31.2	05/20	1018.6
DISW3	47.1N	090.7W	0717	12.8					9.1	NE	30.4	29/05	1017.5
DPIA1	30.3N	088.1W	0719	26.7	28.2				8.8	S	31.6	05/23	1015.5
DSLN7	35.2N	075.3W	0705	24.3	25.3	1.2	3.2	24/09	14.5	SW	32.8	24/02	1016.4
FBIS1	32.7N	079.9W	0719	25.5					9.8	SW	29.4	05/09	1016.4
FFIA2	57.3N	133.6W	0720	10.9					7.3	SW	22.3	30/05	1016.4
FPSN7	33.5N	077.6W	0719	25.4	26.3				13.9	SW	32.8	06/22	1016.4
FWYF1	25.6N	080.1W	0215	28.2					7.5	SE	19.5	21/07	1017.0
GBCL1	27.8N	093.1W	0718	27.1	28.6	0.8	2.8	08/04	10.4	SE	31.8	08/01	1014.8
GDIL1	29.3N	090.0W	0720	27.5	29.1				8.5	S	23.0	07/05	1015.5
GLLN6	43.9N	076.5W	0718	18.2					9.5	W	24.3	16/21	1015.7
IOSN3	43.0N	070.6W	0718	17.6					11.9	SW	33.6	12/00	1014.6
LKWF1	26.6N	080.0W	0716	26.7	27.9				8.1	SE	21.4	10/23	1015.7
MDRM1	44.0N	068.1W	0719	11.5					12.6	SW	33.0	13/20	1012.5
MISM1	43.8N	068.9W	0676	12.9					12.9	SW	28.9	04/14	1012.8
MLRF1	25.0N	080.4W	0716	27.8	28.8				7.8	E	28.7	11/01	1015.4
MPCL1	29.4N	088.6W	0717	27.0	28.2				11.0	SW	29.4	09/18	1015.3
NWPO3	44.6N	124.1W	0720	11.2					7.0	N	32.0	18/01	1018.9
PILM4	48.2N	088.4W	0719	10.2					10.8	W	30.9	26/16	1017.7
PTAC1	39.0N	123.7W	0719	10.4					11.2	N	27.8	12/04	1015.2
PTAT2	27.8N	097.1W	0448	27.6	29.2				12.5	SE	24.5	07/19	1012.4
PTGC1	34.6N	120.7W	0720	11.7					13.8	N	30.2	22/04	1014.6
ROAM4	47.9N	089.3W	0720	12.7	4.7				11.0	NE	34.1	19/00	1018.2
SANF1	24.5N	081.9W	0719	27.7					7.0	E	27.2	07/02	1013.3
SBIO1	41.6N	082.8W	0718	22.0					7.7	NE	27.8	10/23	1016.6
SGNW3	43.8N	087.7W	0718	17.7					9.6	N	30.7	22/01	1017.0
SISW1	48.3N	122.9W	0719	11.3					8.3	W	31.0	03/04	1018.2
SMKF1	24.6N	081.2W	0200	27.4	28.7				7.7	SW	17.5	05/07	1013.9
SPGF1	26.7N	079.0W	0716	27.2	29.0				5.3	SW	26.3	05/00	1015.6
SRST2	29.7N	094.1W	0718	27.1					10.5	S	35.3	28/17	1014.7
STDM4	47.2N	087.2W	0719	13.4					13.6	S	33.0	26/04	1017.7
TPLM2	38.9N	076.4W	0714	23.2	23.7				9.1	S	22.9	05/04	1016.3
TTIW1	48.4N	124.7W	0720	10.6					7.8	S	28.0	20/00	1018.9
VENF1	27.1N	082.5W	0396	26.2	28.5				8.4	W	20.2	07/22	1015.4
WPOW1	47.7N	122.4W	0720	12.8					6.2	S	19.2	20/06	1017.0

This Bulletin shows the recorded Great Lake levels for the previous year and the current year to date, along with the probable levels for the next 6 months. These water levels are compared with the long–term average for each lake. The 6–month levels are prepared by the Detroit District, Corps of Engineers and Environment Canada. The bulletin is distributed each month as a public service. Copies may be obtained free of charge from:

Department of the Army
Detroit District, Corps of Engineers
Attn: CENCE–ED–L
P.O. Box 1027
Detroit, Michigan 48231



MONTHLY BULLETIN OF LAKE LEVELS FOR THE GREAT LAKES

DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1027
DETROIT, MICHIGAN 48231

Headquarters
Mr. Vincent Zegowitz
Marine Obs. Program Leader
National Weather Service, NOAA
1325 East West Highway
Silver Spring, MD 20910
301-427-7724 (FTS 427-7724)

Mr. Martin Baron
VOS Program Manager
National Weather Service, NOAA
1325 East West Highway
Silver Spring, MD 20910
301-427-7724 (FTS 427-7724)

Richard DeAngelis, Editor
Mariners Weather Log, NODC
1825 Connecticut Av., NW
Washington, DC 20235
202-606-4561 (FTS 266-4561)
Fax: 202-606-4586

United Kingdom
Captain Gordon V. Mackie,
Marine Superintendent
Meteorological Office Met O (OM)
Eastern Road, Bracknell
Berks RG12 2UR
Tel:(0344) 855654
Fax: (0344) 485501
Telex: 849801 WEAKAG

Northwest England
Captain Albert Britain, PMO
Room 218,
Royal Liver Building
Liverpool L3 1HU
Tel: 051-236 6565 FAX: 051-2274762

Scotland and Northern Ireland
Captain Stuart M. Norwell, PMO
Navy Buildings, Eldon St.
Greenock, Strathclyde
PA16 7SL
Tel: (0475) 24700
FAX: (0475) 892879

Bristol Channel
Captain Archie F. Ashton, PMO
Cardiff Weather Centre
Southgate House, Wood Street
Cardiff CF1 1EW
Tel: Cardiff(0222) 221423
FAX: (0222) 390435

Southwest England
Captain Douglas R. McWhan, PMO
Southampton Weather Centre
160 High Street
Southampton, S01 OBT
Tel: Southampton (0703) 220632
FAX: (0703) 228846

Southeast England
Captain Clive R. Downes, PMO
Daneholes House, Hogg Lane
Grays, Essex
RM17 5QH
Tel: Grays Thurrock (0375) 378369
FAX: (0375) 379320

Northeast England
Captain Derek H. Rutherford, PMO
Room D418 Corporation House
73-75 Albert Road
Middlesbrough, Cleveland TS1 2RZ
Tel: Middlesbrough (0642) 231622
FAX: (0642) 242676

East England
Captain Edward J. O'Sullivan, PMO
C/O Department of Transport
Posterngate,
Hull HU1 2JN
Tel: Hull (0482) 20158
FAX: (0482) 28957

Rotterdam-Amsterdam
Peter Schnitker, PMO
Aeronautical Meteorological Division
of KNMI
Rotterdam Airport
Tel: (010)- 437 0766

Yokohama Japan
Mr. I. Kawatsu, PMO
Yokohama Local Met. Observatory
Yamate-cho, Naka-ku
Yokohama, Japan
Tel: (045)-621-1991

Tokyo Japan
Mr. M. Miyauchi
Japan Meteorological Agency
Otemachi, Chiyoda-ku
Tokyo, 100 Japan
Tel: (03)-212-8341

New Zealand
Ms. Julie Fletcher
Marine Meteorological Officer
New Zealand Met. Service
Tahi Rd., Box 1515
Paraparaumu Beach, New Zealand
Tel: (058) 73-237

Hong Kong
Mr. Ip Sui Fui, PMO
134A Nathan Road
Kowloon, Hong Kong
Tel: 732-9263

SEAS Field Representatives
Mr. Robert Decker
Seas Logistics/ PMC
Fairview Av. East
Seattle, WA 98102
206-553-8347 (FTS 399-8347)
FAX: 206-442-1710

Mr. Steven Cook
SEAS Operations Manager
8604 La Jolla Shores Dr.
La Jolla, CA 92037
619-546-7103 (FTS 893-7103)
FAX: 619-546-7003

Mr. Jim Farrington
SEAS Logistics/ A.M.C.
439 West York St.
Norfolk, VA 23510
804-441-3062 (FTS 827-3062)
FAX: 804-441-6495

Mr. Robert Benway
National Marine Fisheries Service
28 Tazwell Dr.
Narragansett, RI 02882
401-782-6295 (FTS 838-6295)

Mr. Warren Krug
Atlantic Oceanographic & Met. Lab.
4301 Rickenbacker Causeway
Miami, FL 33149
305-361-4433 (FTS 350-1433)
FAX: 305-361-4582

Steve Ranne, Petty Officer USN
FLENUMOCEANCEN, Code 64
Monterey, CA 93943
408-647-4428 FAX: 408-647-4489

Atlantic Ports

Mr. Peter Connors, PMO
National Weather Service, NOAA
1600 Port Boulevard
Miami, FL 33132
305-358-6027

Mr. Lawrence Cain, PMO
National Weather Service, NOAA
Jacksonville International Airport
Box 18367
Jacksonville, FL 32229
904-741-4370 (FTS 946-3620)

Mr. Earle Ray Brown, Jr., PMO
National Weather Service, NOAA
Norfolk International Airport
Norfolk, VA 23518
804-441-6326 (FTS 827-6326)

Mr. James Saunders, PMO
National Weather Service, NOAA
Weather Service Office
BWI Airport
Baltimore, MD 21240
301-850-0529 (FTS 922-2177)

PMO
National Weather Service, NOAA
Building 51
Newark International Airport
Newark, NJ 07114
201-624-8118 (FTS 341-6188)

Mr. Dee Letterman, PMO
National Weather Service, NOAA
30 Rockefeller Plaza
New York, NY 10112
212-399-5569 (FTS 662-5569)

Mr. Randy Sheppard, PMO
Atmospheric Environment Service
1496 Bedford Highway
Bedford, (Halifax) Nova Scotia
B4A 1ES
902-426-9225

Mr. Denis Blanchard
Atmospheric Environment Service
100 Alexis Nihon Blvd., 3rd Floor
Ville St. Laurent, (Montreal) Quebec
H4M 2N6
514-283-6325

Mr. D. Miller, PMO
Atmospheric Environment Service
Bldg. 303, Pleasantville
P.O. Box 9490, Postal Station "B"
St. John's, Newfoundland
A1A 2Y4
709-772-4798

Pacific Ports

PMO, W/PRx2
Pacific Region, NWS, NOAA
Prince Kuhio Fed. Bldg., Rm 411
P.O. Box 50027
Honolulu, HI 96850
808-541-1670

Mr. Robert Webster, PMO
National Weather Service, NOAA
2005 T Custom House
300 South Ferry Street
Terminal Island, CA 90731
213-514-6178 (FTS 795-6178)
TELEX: 7402731/BOBW UC

Mr. Robert Novak, PMO
National Weather Service, NOAA
Coast Guard Island P.O. Box 5027
Alameda, CA 94501
510-273-6257 (FTS 536-6257)
TELEX: 7402795/WPMO UC

Mr. David Bakeman, PMO
National Weather Service, NOAA
7600 Sand Point Way, N.E.
BIN C15700
Seattle, WA 98115
206-526-6100 (FTS 392-6100)

Mr. Bob McArter, PMO
Atmospheric Environment Service
700-1200 W. 73rd Av.
Vancouver, British Columbia
V69 6H9
604-664-9136

Mr. Lee Kelley, MIC
National Weather Service, NOAA
Kodiak, AK 99619
Box 37, USCG Base
907-487-2102/4338

Mr. Lynn Chrystal, OIC
National Weather Service, NOAA
Box 427
Valdez, AK 99686
907-835-4505

Marine Program Mgr. W/AR121x3
Alaska Region, National Weather Service
222 West 7th Avenue #23
Anchorage, AK 99513-7575
907-271-5121 (FTS 868-5121)

Great Lakes Ports

Mr. Bob Collins, PMO
National Weather Service, NOAA
333 West University Dr.
Romeoville, IL 60441
815-834-0600

Mr. George Smith, PMO
National Weather Service, NOAA
Hopkins International Airport
Federal Facilities Bldg.
Cleveland, OH 44135
216-267-0069 (FTS 942-4949/4517)

Port Meteorological Officer
Atmospheric Environment Service
25 St. Clair Av. East
Toronto, Ontario
M4T 1M2
416-973-5809

Mr. Ronald Fordyce
National Water Research Institute
Port Meteorological Office
P.O. Box 5050
867 Lakeshore Rd.
Burlington, Ontario
416-336-6420 (FAX 416-336-4797)

Gulf of Mexico Ports

Mr. John Warrelmann, PMO
National Weather Service, NOAA
Int'l Airport, Moisant Field, Box 20026
New Orleans, LA 70141
504-589-6697 (FTS 682-6697)

Mr. James Nelson, PMO
National Weather Service, NOAA
Houston Area Weather Office
1620 Gill Road
Dickinson, TX 77539
713-534-2640 (FTS731-2640)

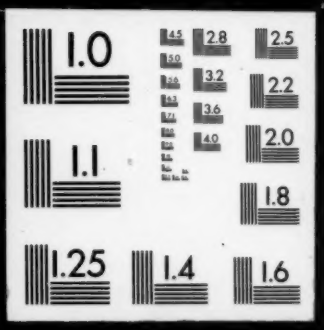
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data and Information Service
National Oceanographic Data Center
Washington, DC 20235

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

Postage and Fees Paid
U.S. Department of Commerce
COM-210

First Class Rate

For Sale by the Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402


1.0
1.1
1.25
1.4
1.6
2.8
2.5
3.2
2.2
3.6
2.0
4.0
1.8